

YUKON RIVER ANADROMOUS FISH INVESTIGATIONS
TECHNICAL REPORT FOR PERIOD
JULY 1, 1978 to JUNE 30, 1979

YUKON RIVER SALMON STUDIES

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February 1979

RECEIVED

Project No. AFC-63-2
Anadromous Fish Conservation Act

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Prepared for:

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Washington, D.C. 20235

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ABSTRACT

The 1978 commercial catch of 97,100 king salmon was the largest since 1974. The subsistence catch for this species was 30,000 fish. Summer chum salmon commercial catches in 1978 totaled a record 1,053,000. The total commercial harvest of fall chums in 1978 was 235,000 and the subsistence catch equaled 95,000.

Escapements in 1978 were generally good to excellent for both king and summer chum salmon. Fall chum escapements were considered good in the Tanana system, but poor in the upper Yukon-Porcupine.

The expanded Anvik tower count of 150,000 summer chum salmon in 1978 was the lowest count since 1974, the parent year for the 1978 spawning escapement.

During the falls of 1976, 1977, and 1978, 16,243 fall chum salmon were tagged. Tagging took place in the mid-Yukon areas from just upstream of Galena to 30 miles upstream of Tanana Village. To date, 7,318 or 45% of the tags have been recovered.

Ninety-seven percent of the recoveries for north bank tagged chums, recovered above the Tanana confluence, have been made in upper Yukon-Porcupine drainage. Ninety-one percent of chums tagged along the south bank and recovered above the Tanana confluence have been recovered in the Tanana drainage.

Simple Petersen population estimates of the Yukon fall chum run have been made: 1978, 460,000; 1977, 513,000; and 1976, 331,000. Exploitation rates of 0.74, 0.66, and 0.71 have been calculated for 1978, 1977, and 1976, respectively.

The rate of exploitation of upper Yukon-Porcupine stocks by the upper Yukon fisheries was 0.71 for 1978. The rate of exploitation of Tanana and Toklat stocks was 0.44 and 0.45, respectively.

Figure 1. Yukon River Map

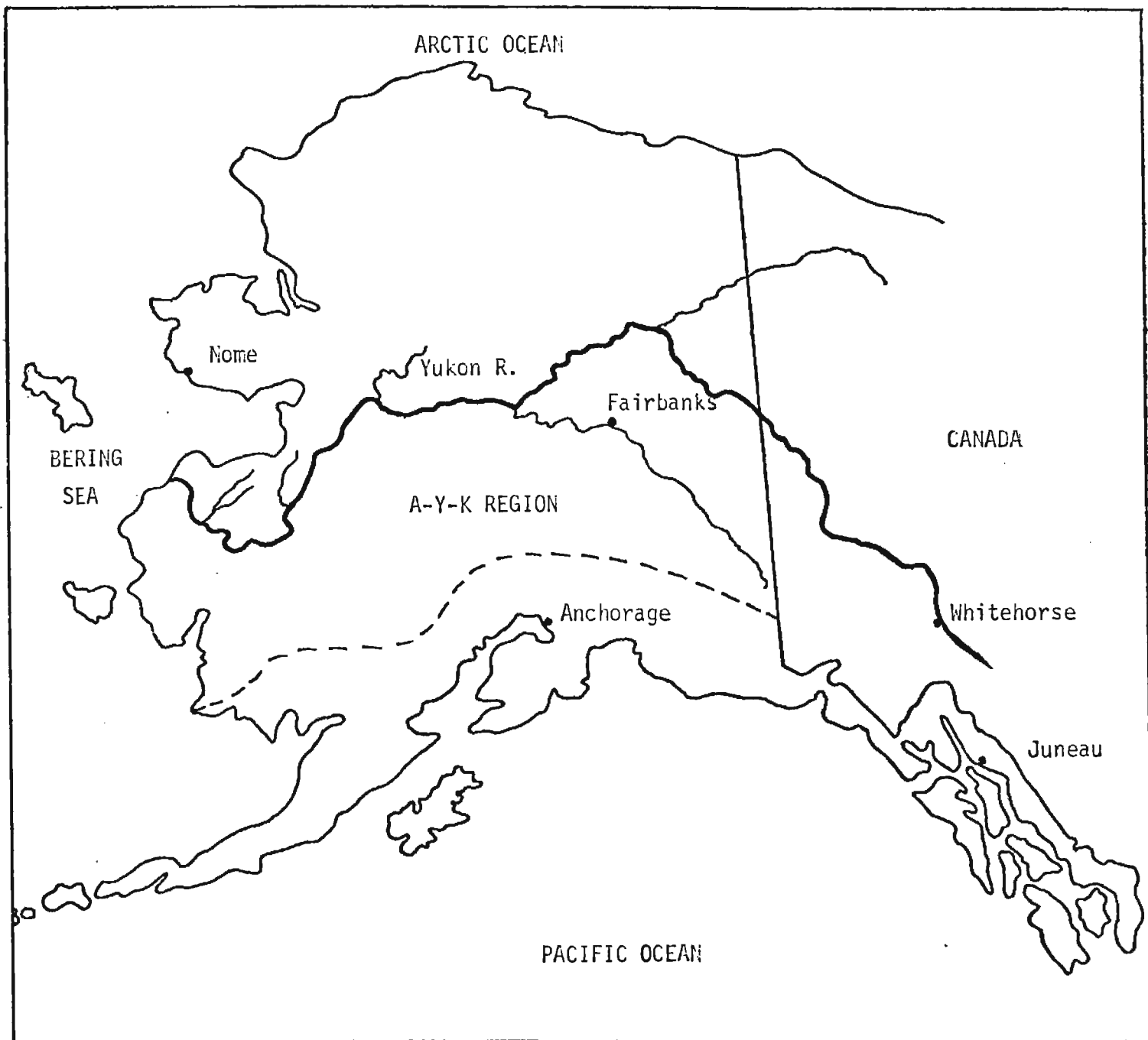


FIGURE 2. Lower Yukon River map.

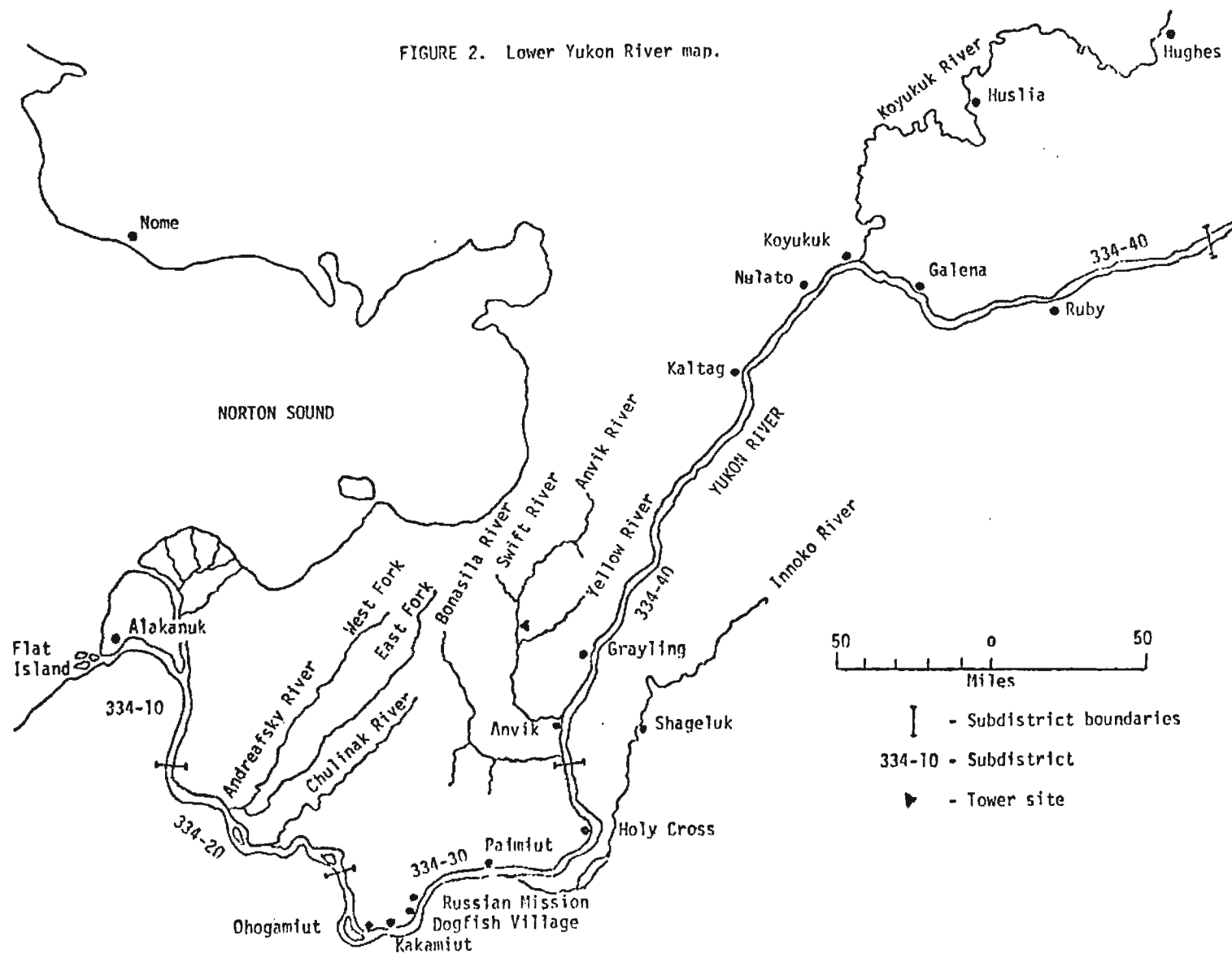


FIGURE 3. Mid-Yukon River map

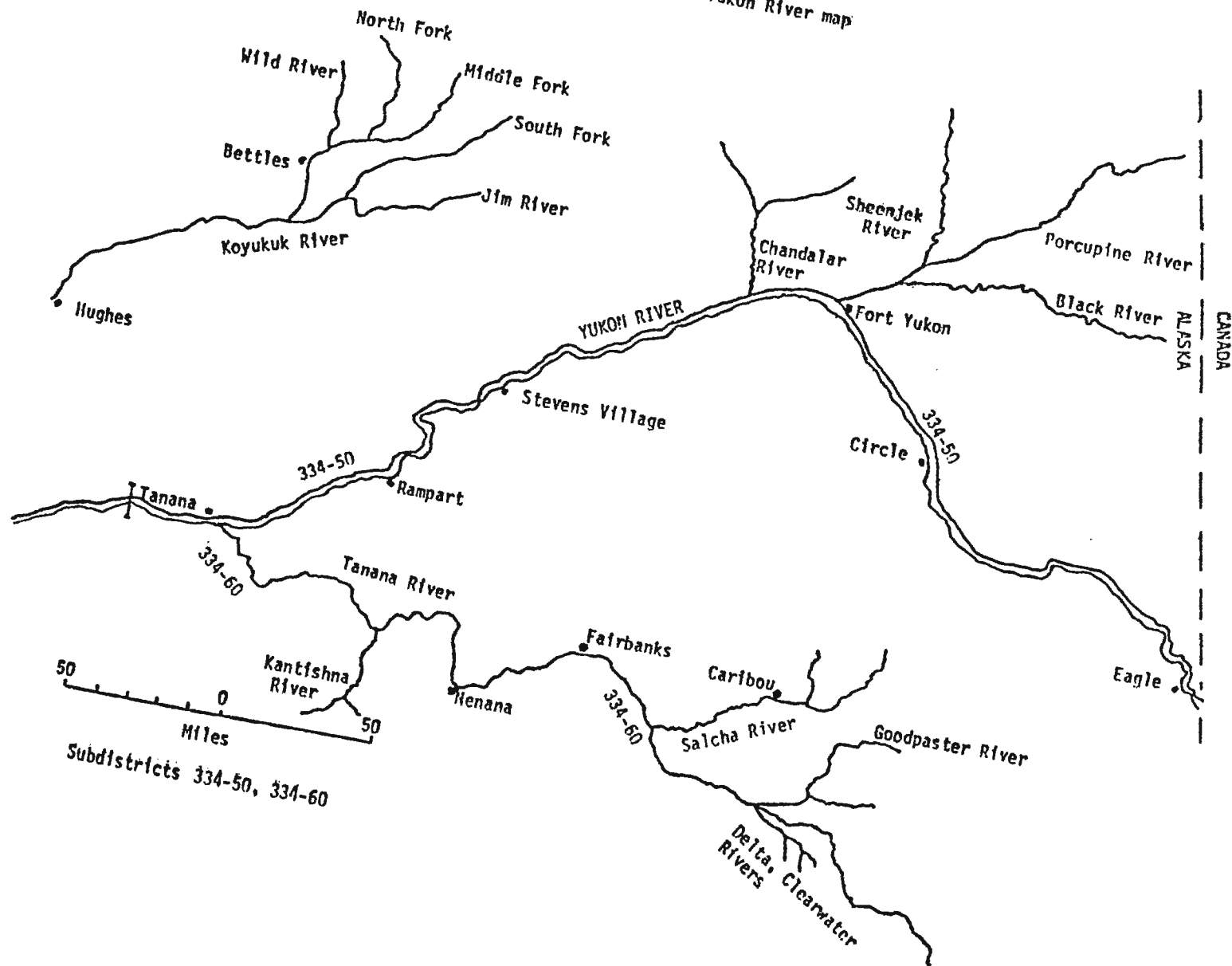
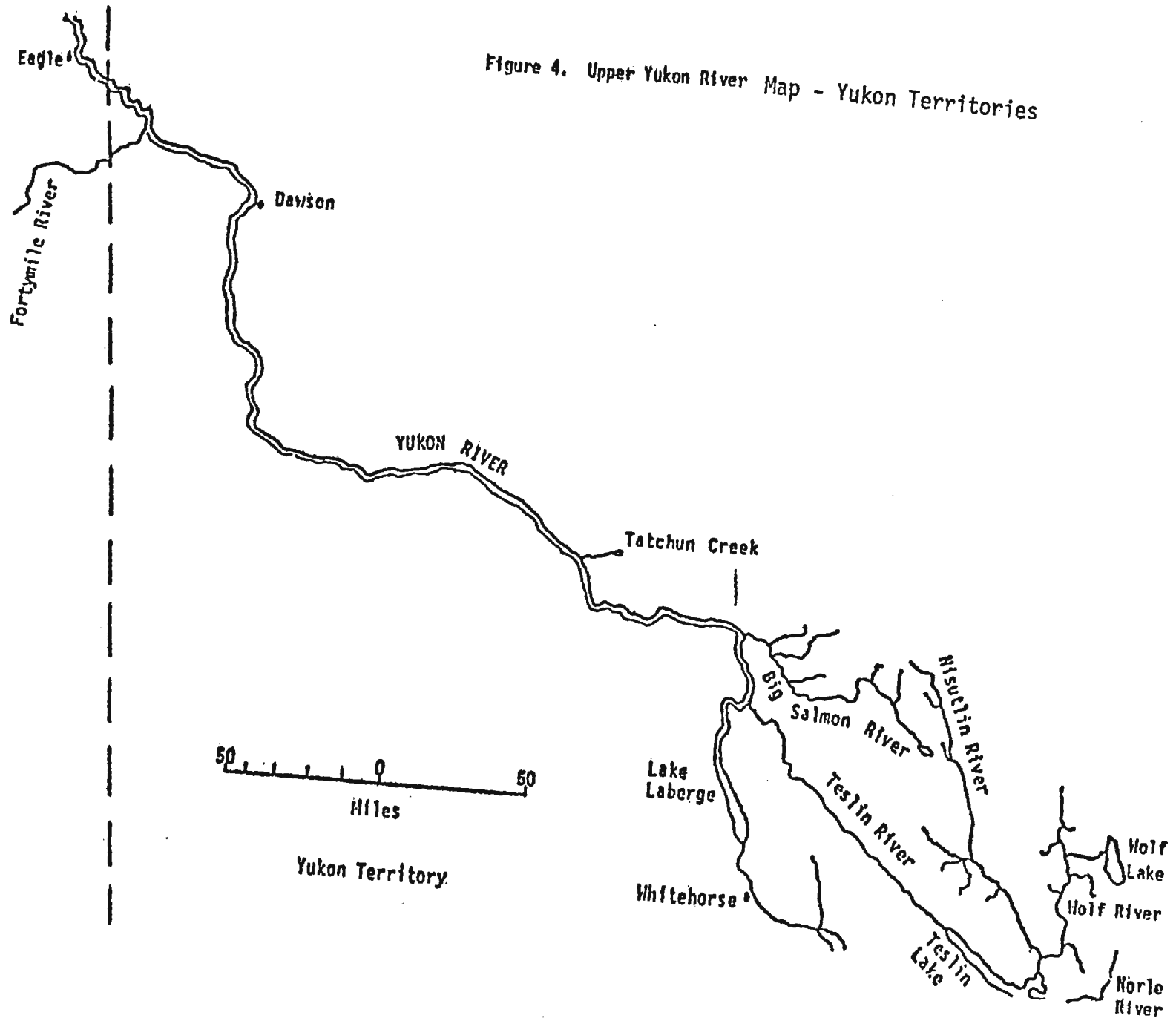


Figure 4. Upper Yukon River Map - Yukon Territories



largest since 1974. The average commercial catch of king salmon for the 5 years prior to 1978 was 84,400. The subsistence catch for this species was approximately 30,300.

Summer chum salmon commercial catches in 1978 totaled a record 1,053,200 exceeding the previous 5 year average of 499,700 fish. A total of 197,100 summer chums were taken for subsistence. Subsistence utilization of summer chums has generally declined in recent years.

The commercial harvest of fall chum salmon in 1978 was 234,800 and the subsistence catch totaled 94,900 fish. The 1978 commercial harvest was similar to the recent 5 year average of 243,000 fish.

The 1978 commercial coho salmon catch of 25,600 fish exceeded the previous 5 year average of 19,600 fish.

Flat Island Test Fishing

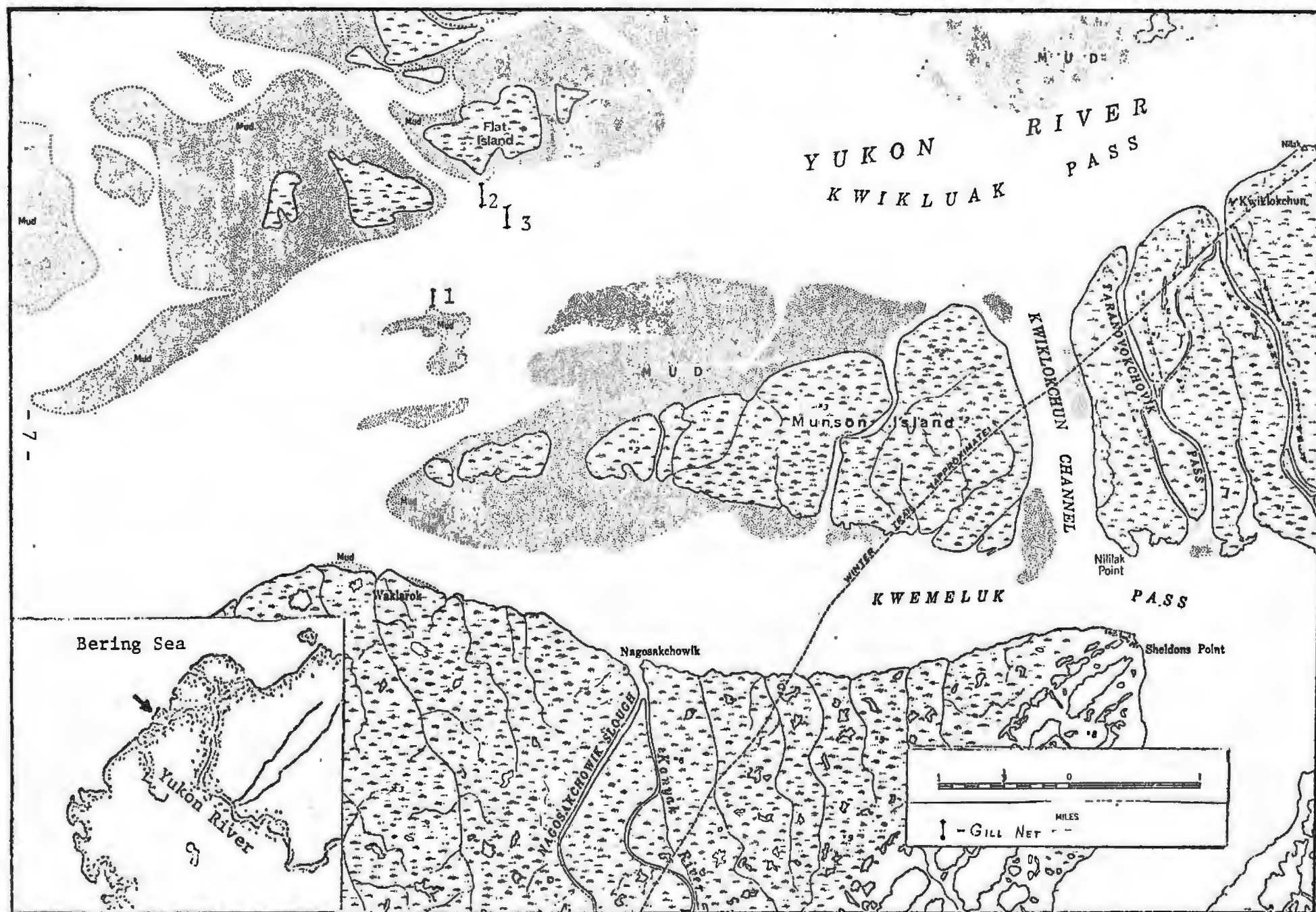
A test fishing site has been maintained at Flat Island in the south mouth of the Yukon River since 1963 (Figure 5). The Flat Island site is located downstream from most of the commercial fishing effort permitting the salmon run to be assessed before it reaches the commercial fishery. The data obtained from this site has been important for in-season management and in assessing the long-term effects of the commercial fishery on the king and summer chum salmon runs.

The sampling gear consists of two 8-1/2" (king salmon gear) and one 5-1/2" (chum salmon gear) stretched mesh set gill nets. Each net is 25 fathoms long and the nets are 28 (8-1/2") and 45 (5-1/2") meshes deep. The nets are fished 24 hours a day at index locations from early June to mid-July and checked three times daily.

Test fishing values derived from this study over the past 10 years indicate trends in abundance for chum salmon (Geiger and Andersen 1979). King salmon catches between years are not directly comparable; catch data for this species is used primarily to indicate king passage during periods of time when the commercial fishery is closed.

A total of 936 king and 3,539 summer chum salmon was taken in index set gillnets from May 29 through July 14 during 1978. Peaks in the king salmon migration occurred during June 2-4 and June 10-11 and peaks in the summer chum migration occurred during June 10-18 and June 26-28, 1979. From May 29 through July 14, 1977, 805 kings and 2,951 summer chum were taken.

Figure 5. Flat Island test fishing sites, Yukon River, 1978.



Yukon Territory Salmon Escapement Studies

Environment Canada-Fisheries Service personnel enumerated and sampled king salmon migrating through the Whitehorse fishway in 1978. The fishway is located at the Whitehorse Dam upstream of the city of Whitehorse and is one of the farthest upstream king salmon escapement monitoring points on the Yukon River. Since 1969 the annual fishway counts and the age and sex composition of the run have been used as a possible indicator of the effects of the downriver fishery on king salmon escapement in the Canadian portion of the Yukon drainage. The objectives of the study over the years have been to: (1) obtain a daily and seasonal count of king salmon escapement through the fishway, and (2) determine the age, sex, and size composition of the Whitehorse escapement.

Seven hundred and twenty five king salmon were enumerated at the Whitehorse fishway in 1978 (Table 1) the greatest number since 1971. An examination of the annual escapement counts since 1959 indicates that the Whitehorse run has experienced a serious decline. Possible reasons for the decline are discussed in detail in the 1973 Yukon River Anadromous Fish Investigations Report (Trasky 1974).

Fifty-four kings passed at the Whitehorse fishway were examined for sex and scales were taken for age determination^{1/}. Scales were read by Canadian personnel with the following results: Two females were age 4₂, 5 were 5₂, and 18 were 6₂; for males the numbers for the latter two age categories were 17 and 12, respectively.

During 1978, aerial and foot surveys were conducted of major spawning streams in the Yukon Territory with ADF&G personnel participating in some surveys. Observed escapement by stream surveyed was: Takhini River 115; Nordenskjold River 17; Nisutlin River 375; Nisutlin Lake Outlet 109; Big Salmon River 1,150; Little Salmon River 330; and Tatchum Creek 200. The Big Salmon escapement was the historically highest documented for this system.

Fall chum salmon escapements of the Fishing Branch River (a tributary of the Porcupine River) in northern Yukon Territory were monitored by Alaskan personnel in 1978. Both helicopter and foot surveys were included during 1977 and 1978. A 10 mile spring-fed section of the south fork of this river remains ice-free during winter and is heavily used by fall chums

^{1/} Gilbert-Rich formula - total years of life at maturity (large type) - year of life at outmigration from fresh water (subscript).

Table 1. Comparative king salmon escapement estimates, Yukon River drainage, 1959-1978. 1/

Year	Andreafsky River (East Fork)	Andreafsky River (West Fork)	Nulato River	Anvik River
1960	1,020	1,220	756	1,950
1961	1,003		543	1,226
1962	675 <u>2/</u>	762 <u>2/</u>		
1963				
1964	867	705		
1965		355 <u>2/</u>		650 <u>2/</u>
1966	361	303		638
1967		276 <u>2/</u>		336 <u>2/</u>
1968	380	383		297 <u>2/</u>
1969	231 <u>2/</u>	274 <u>2/</u>		296 <u>2/</u>
1970	665	574 <u>2/</u>		368 <u>2/</u>
1971	1,904	1,284		
1972	798	582 <u>2/</u>		1,172 <u>4/</u>
1973	825	788		613 <u>4/</u>
1974		285	78	506 <u>5/</u>
1975	993	421	204	720 <u>6/</u>
1976	818	643	648	1,155 <u>6/</u>
1977	2,008	1,499	487	1,354 <u>6/</u>
1978	2,487	1,062	920	1,281 <u>6/</u>

Year	Chena River	Salcha River	Nisutlin River (Sidney-100 Mi. Cr.)	Whitehorse Dam Fishway
1959				1,054
1960	132	1,660		660
1961		2,878		1,068
1962		937		1,500
1963				484
1964		450		587
1965		408		903
1966		800		563
1967				533
1968		735	407	407
1969		461 <u>2/</u>	105	334
1970		1,882	615	625
1971	193 <u>2/7/</u>	159 <u>2/</u>	640 <u>3/</u>	856
1972	138 <u>2/7/</u>	1,193	317	392
1973	21	249	36 <u>2/</u>	228
1974	1,035 <u>7/</u>	1,857	48 <u>2/</u>	273
1975	316 <u>7/</u>	1,055	249	313
1976	531	1,691	102	120
1977	563	1,202	77	277
1978	1,726	3,499	375	725

1/ With exception of Whitehorse fishway counts, the data was obtained from aerial surveys which were made only of the main stem of each river listed.

2/ Incomplete survey or poor survey conditions resulting in a very minimal count.

3/ Environment Canada - Fisheries Service survey.

4/ Combination tower counts and aerial survey estimates.

5/ Tower count.

6/ Combination aerial and boat surveys.

7/ Boat surveys.

(Elson 1976). A total of 15,000 chums was estimated by aerial survey in 1978 (Table 2). During the years 1973-75 a weir was used to obtain a total escapement count. Numbers of chum salmon enumerated past the Fishing Branch River weir in 1975 was a record 353,000 fish.

A total of 9,600 chum salmon was harvested by commercial and subsistence fishermen in the Yukon Territory during 1978 (Ottmann 1979). These chums were largely fall fish. A total of 6,300 king salmon was also harvested in the Yukon Territory commercial and subsistence fisheries combined during 1978.

Aerial Surveys

Because of the vast distances between salmon spawning streams in the Yukon River drainage, salmon escapements are primarily assessed by aerial survey methods. Index streams have been chosen which may be indicative of overall Yukon River basin escapements. During the peak of spawning, and when water and light conditions are optimum for viewing, these streams are surveyed by Department biologists in single engine aircraft. While not precise, aerial surveys are an important management tool when no other means of assessing escapements are available. Escapement indices obtained from aerial surveys and other escapement enumeration methods (e.g. weirs, towers, sonar, foot, and boat surveys) give a post-season check of in-season management strategy in obtaining desired escapement levels.

In 1978, king salmon escapements into the major spawning areas ranged from above average to average. Record escapements were documented in the east fork of the Andreafsky, Nulato, Chena, and Salcha Rivers with counts of 2,487; 920; 1,726; 3,499 fish, respectively (Table 1). The Big Salmon River in Yukon Territory also had a record run with 1,150 kings.

Summer chum escapements in 1978 were judged good throughout the drainage. A total of 530,000 summer chums were documented in selected escapement surveys. Since 1974 total documented escapements have ranged from 356,100 to 1,621,500 fish. In Table 3 the ten major summer salmon streams in the Yukon River system are ranked based on numbers of spawners for the years 1975 through 1978. The Anvik River has had the high documented escapement for each year during this time period. The total Anvik count in 1978 was 251,000. Other Yukon summer chum streams exceeding 10,000 escapement with their respective escapements were Andreafsky E. - 127,000; Andreafsky W. - 57,000; Nulato N. - 39,000; Rodo 18,000; Nulato S. - 15,000.

Aerial survey is the only method currently available to assess fall chum escapement in most Alaskan waters (see Figure 12 for major Yukon

Table 2. The ten most important Yukon River drainage fall chum salmon streams ranked by escapement, 1975-1978. 1/

1978 ^{2/3/4/}			1977			1976		1975	
Ranking	Stream	Escapement	Ranking	Stream	Escapement	Stream	Escapement	Stream	Escapement
1	Toklat	35	1	Fishing Branch	33	Toklat	37	Fishing Branch	353
2	Fishing Branch	15	2	Toklat	25 ^{3/}	Fishing Branch	13	Toklat ^{2/}	78
3	Sheenjek	15	3	Sheenjek	21	Sheenjek	12	Sheenjek	78
4	Delta	10	4	Delta	18	Delta	6	Yukon River (Mainstem, Canada)	7
5	South Bank Tanana	6	5	Bluff Cabin Slough	6	Tanana	5	Chandalar	6
6	Bluff Cabin Slough	5	6	Chandalar	4 ^{3/}	Bluff Cabin (Slough ^{2/})	3	Bluff Cabin	5
7	Benchmark 735	2	7	Upper Tanana	4	Delta Clwtr Slough	2	Delta	4
			8	Delta Clearwater	2	Benchmark 735 Sl.	^{4/}	Bear Paw	2
			9	Benchmark 735	1	Richardson Clwtr ^{2/}	^{4/}	Black ^{3/}	2
			10	Kluane	1	Chandalar ^{2/}	^{4/}	Delta Clearwater (Slough ^{2/})	4
Total		88			115		78		539

1/ Escapement in thousands of salmon.

2/ In 1978 only 7 of those streams surveyed had in excess of 1000 chums.

3/ Poor survey conditions.

4/ Less than 500 fish.

Table 3. The ten most important Yukon River drainage summer chum salmon streams ranked by observed escapement, 1975-1978. 1/

Ranking	1978 Stream	Escapement	Ranking	1977 Stream	Escapement	Stream	1976 Escapement	Stream	1975 Escapement
1	Anvik	251 <u>2/ 3/</u>	1	Anvik	263 <u>2/3/4/</u>	Anvik <u>2/3/4/</u>	406	Anvik <u>2/3/</u>	813
2	Andreafsky E.	127	2	Andreafsky East	113	Andreafsky West	118	Andreafsky West	236
3	Andreafsky W.	57	3	Andreafsky West	63	Andreafsky East	105	Andreafsky East	223
4	Nulato N.	39	4	Nulato North	58	Rodo	38	Nulato North	87
5	Rodo	18	5	Rodo	16	Chulinak	34	Gisasa	57
6	Nulato S.	15	6	Thompson	15	Nulato North	27	Nulato South	51
7	Gisasa	9	7	Nulato South	11	Gisasa	21	Rodo	25
8	Melozitna	6	8	Gisasa	2	Thompson Creek	17 <u>2/</u>	Caribou Creek	15
9	Salcha	5	9	Clear	2 <u>2/</u>	Nulato South	12	South Fork Koyukuk	15
10	South Fork Koyukuk	3	10	Mt. Village	2	Caribou Creek	11	Melozitna	9
	Total	<u>530</u>			<u>545</u>		<u>789</u>		<u>1,531</u>

1/ Escapement in thousands of salmon.

2/ Streams surveyed under poor survey conditions. Survey conditions in the lower Anvik has been fair to poor for all years on record.

3/ Includes sum of tower and aerial counts.

4/ Includes Yellow River.

fall spawning areas). Environmental and light conditions during peak fall chum spawning (late September through mid-November) are generally less conducive to reliable surveys than during the summer. Short periods of daylight, shadows, streams running ice, and snow squalls are limiting factors encountered during fall surveys.

Fall chum escapements were considered good in the Toklat River, but poor in the Sheenjek and Fishing Branch Rivers during 1978. These streams accounted for 85% of total documented fall chum escapements for the years 1974 through 1978 combined. In Table 2, the top ten fall chum salmon streams for 1975 through 1978 are ranked based on numbers of spawners. Only four of the fall systems surveyed in 1978 contained escapements in excess of 10,000. These four with their respective escapements in thousands were: Toklat 35; Fishing Branch 15; Sheenjek 15; and Delta 10.

Summer Chum Salmon Population Estimation

Using catch and escapement data (presented in Appendix Tables 1 and 2), an attempt has been made to estimate the size of the total Yukon River summer chum salmon run. Total harvest is considered the sum of commercial and subsistence catches, while total run is assumed to be the sum of harvest plus escapement. For this purpose the documented escapement is assumed to be the total escapement. Prior to 1974 escapement data was very incomplete, because the major Anvik River run was not surveyed. To arrive at an estimated total Yukon run for years with incomplete data, a ratio was calculated between Anvik and total Yukon documented escapement for known years 1974-1978. The Anvik run was found to equal approximately 50% of the total Yukon run for these years. Yukon escapement figures for 1970, 1972, and 1973 were, therefore, expanded by 50%. Calculated run size estimates subsequently ranged from 561,000 in 1973 to 2,547,000 fish in 1975. Harvest exploitation rates ranged from 28 to 70% for the years 1970 through 1978. Sources of error in the run estimates include: (1) undocumented escapements and catches, and (2) the use of an average figure in making expansions.

ANVIK RIVER SALMON ESCAPEMENT STUDIES

Introduction

The Anvik River is the single most important chum salmon producer in the Yukon drainage. About 1 million chum are believed to have returned to the Anvik in 1975. The Anvik is also a major contributor to Yukon king salmon production. It is one of four Alaska tributaries regularly documented to have annual escapements in excess of 1,000 kings. A physical description of the Anvik system including water temperature data as well as an abridged listing of its flora and fish species is included in the 1976 Completion Report (Mauney 1977).

Salmon were enumerated for the seventh consecutive year to obtain indices of the magnitude of king and summer chum salmon escapements in the Anvik River system. The objectives of this project were to: (1) determine the daily and seasonal timing and magnitude of salmon escapements; (2) evaluate various enumeration methods by comparing aerial survey, boat survey, and tower counts; (3) determine age, sex, and size components of the king and chum salmon escapements; (4) evaluate different counting tower schedules; (5) measure climatological and hydrological conditions; and (6) continue field testing a Bendix Corporation acoustic side scan salmon counter.

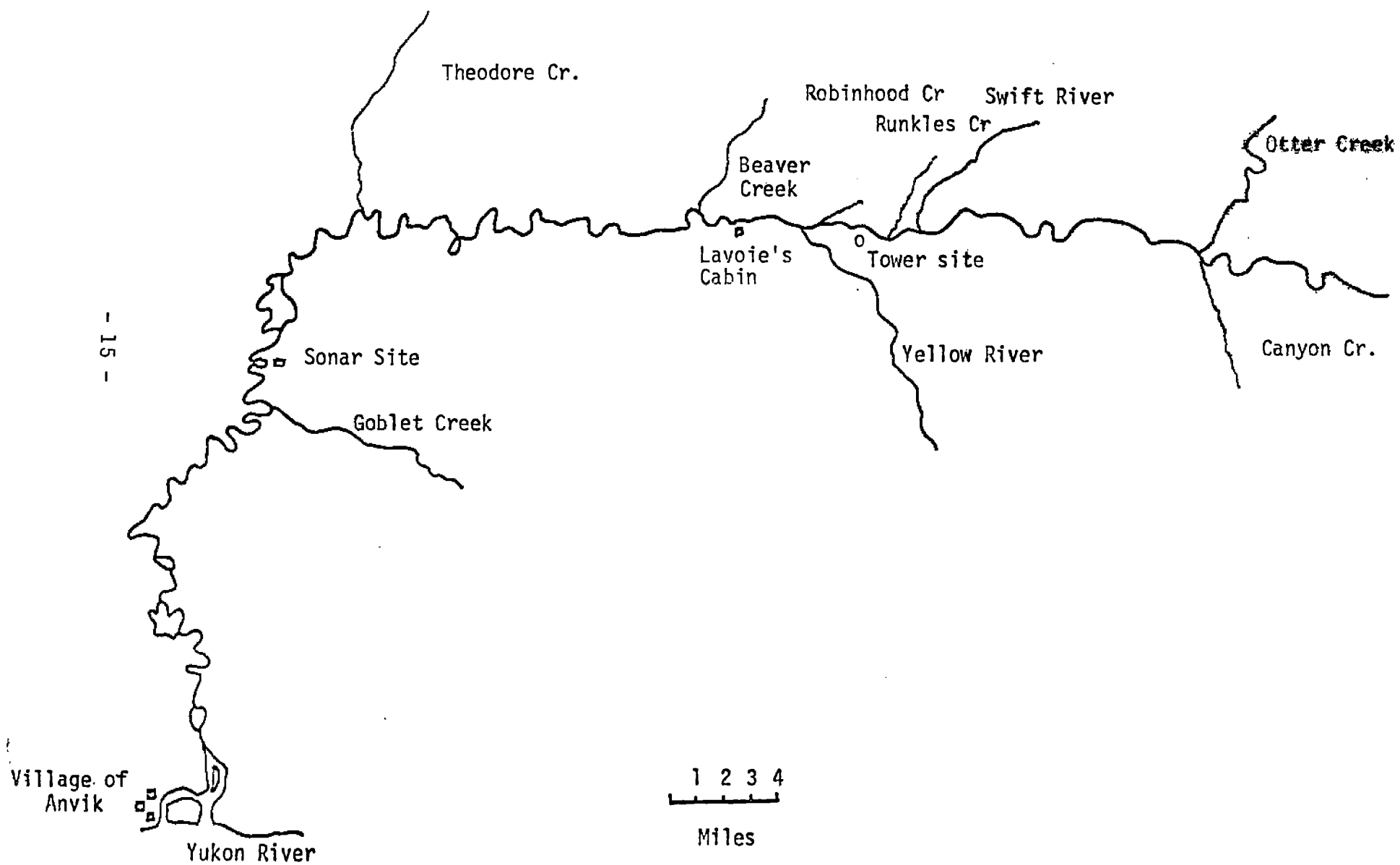
Methods and Materials

Methods and materials used in the counting tower operation were similar to those used by Trasky in 1974 (Trasky 1975) and by Mauney in 1975, 1976, and 1977 (Mauney 1977).

The Robinhood Creek tower site is located some 70 miles upstream from Anvik village (the Anvik enters the Yukon at Yukon River Mile 317), see Figure 6. Materials for weir construction were transported to the Robinhood Creek site from Anvik village by riverboat and from Bethel by aircraft following ice out in early June. Tents for living, mess quarters, and for equipment storage were erected on the west bank of the River immediately downstream from the planned weir site.

By mid-June of 1978 the water level at the Robinhood Creek location had dropped sufficiently for weir construction to begin. The weir was essentially completed on June 18 following 3 days of installation. Initially, the entire width of the river was weired with the exception of a 40 foot center section where maximum flow rate and water depth were reached. The counting tower was to be erected on a log raft anchored just upstream of the weir. Heavy rains began and continued throughout June into early July. Extremely

Figure 6. Anvik River Map.



high runoff resulted from the torrential rains necessitating the removal of the weir before it was washed out. In anticipation of an unusually early salmon run and in view of continued extremely high, turbid water conditions through June 22, it was decided to install the side scan sonar at the Robin-hood Creek site rather than in the lower River as initially planned. The sonar and an associated counting tower were installed approximately 100 yards upstream from the 1977 weir site.

Counting shifts were normally a maximum of 2 hours duration. Visual salmon counts were initiated on June 22 and sonar counts were initiated on June 24.

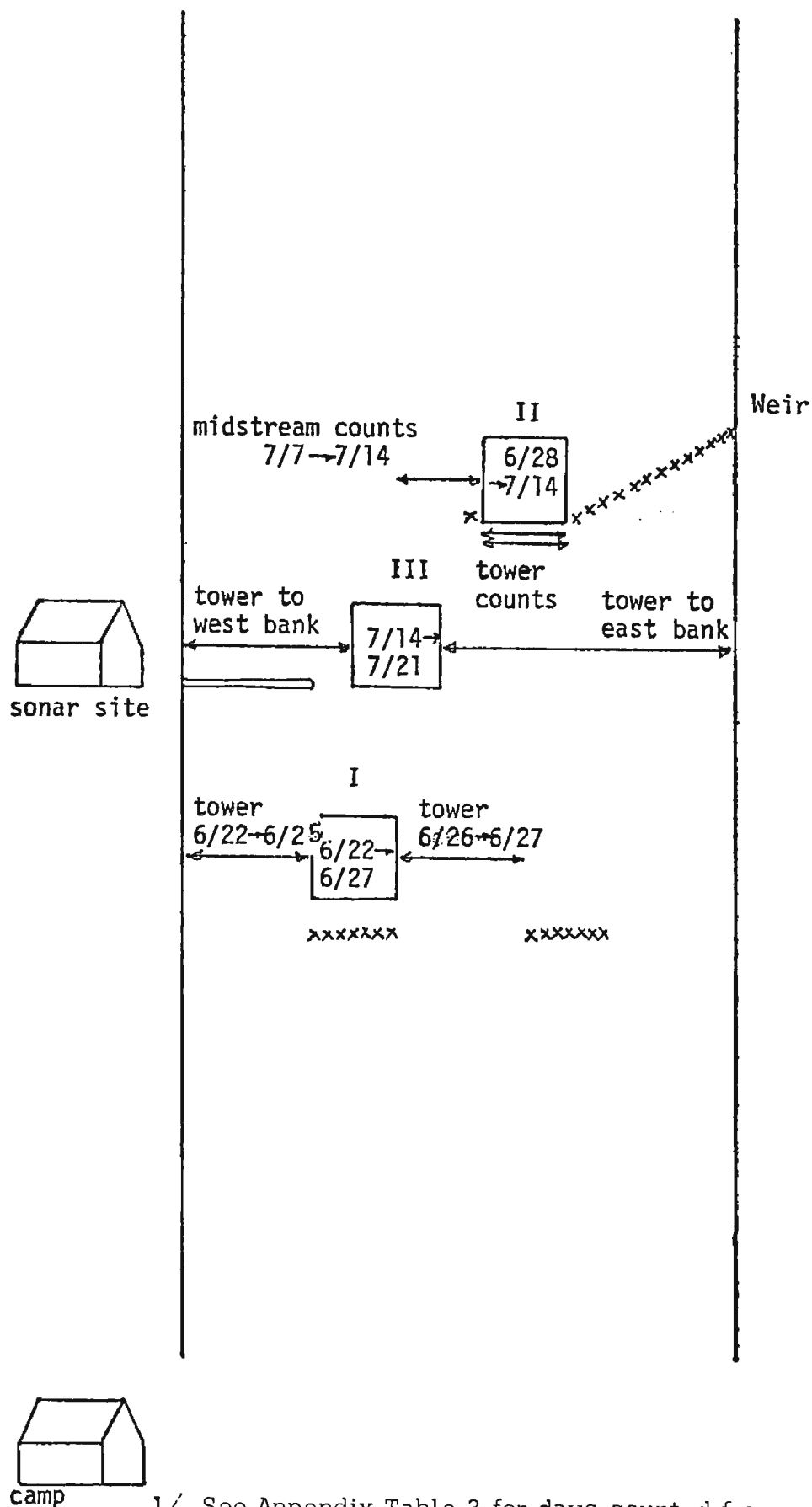
During 1978 operations, tower counts were made from three different locations. One counting tower was erected on the bank at the sonar site. A second counting tower was operated from a log raft anchored at different midstream locations. The midstream locations for the counting tower along with dates of counting in the respective locations are given in Figure 7.

From 6/22 to 6/25 the counts were from the tower (Position 1) to the west shore. This is the side the majority of the fish appeared to be moving up (due to high water the weir was incomplete and the far east shore could not be seen sufficiently from the tower to conduct counts on that side). Counts were expanded to include the whole river, assuming the counts made actually represented 50% of the total fish movement upstream. To avoid duplicating the west bank sonar counts, on 6/26 and 6/27 counts were from the midstream tower facing east and covered only salmon moving up midstream.

The tower was relocated further upstream to Position 2 on 6/27 and until 7/7 counts were east bank oriented only and covered only those fish crossing the background panel which had been installed off the end of the east bank weir. By 7/7 it was apparent that some fish moving up midstream outside the background panel were not being counted by either the tower or the sonar. From this date on, midstream counts were also made from the tower and recorded on separate sheets under the heading Chum-Midstream (these midstream counts covered any fish between the west end of the canvas background panel and two rocks located approximately 20 feet from that point - some duplicates from the sonar counts were probable, but it was assumed these were not numerically significant).

The midstream counts terminated on 7/14 when the tower was moved downstream to Position 3. At this time the sonar counts were terminated and the raft was located opposite the sonar site utilizing the sonar substrate as a background (on 7/15). To cover the entire river, 15 minute counts were made from the tower to the east shore (for chums these were recorded separately on the sheets entitled: Chum - Tower to east shore). Forty-five minute counts were made from the tower to the west bank.

Figure 7. Dates and locations of raft counting, Anvik River, 1978. 1/2/



- 1/ See Appendix Table 3 for days counted from each location.
2/ Not drawn to scale or channel configuration.

Chum salmon carcass sampling and enumeration surveys were conducted from boats upstream and downstream of the tower site from July 23 to July 28. A scale smear was taken from each fish sampled, length (mid-eye to fork of tail) measured, and sex of each carcass recorded. Carcasses merely counted were recorded as to sex. King salmon carcass surveys were made of the main Anvik River above Lavoie's cabin from August 1 through 12. Data collected were the same as for chum salmon.

During aerial surveys on July 14 and 15, king and chum spawners and carcasses were counted and distribution of species determined in the river system below the counting tower. These surveys included Beaver Creek and Yellow River tributaries. Survey reliability for the lower Anvik and Yellow River was judged 50% or less due to turbid water conditions. Spawning king salmon were counted between the 1975 tower site and Beaver Creek on July 19 (a distance of some 8 miles) by drifting in a boat.

Six personnel operated the combined tower and sonar installation in 1978. Five personnel operated the combined tower and sonar installation in 1976 and 1977. Three temporary personnel were involved in Anvik studies during 1974 and 1975, when only the counting tower was in operation.

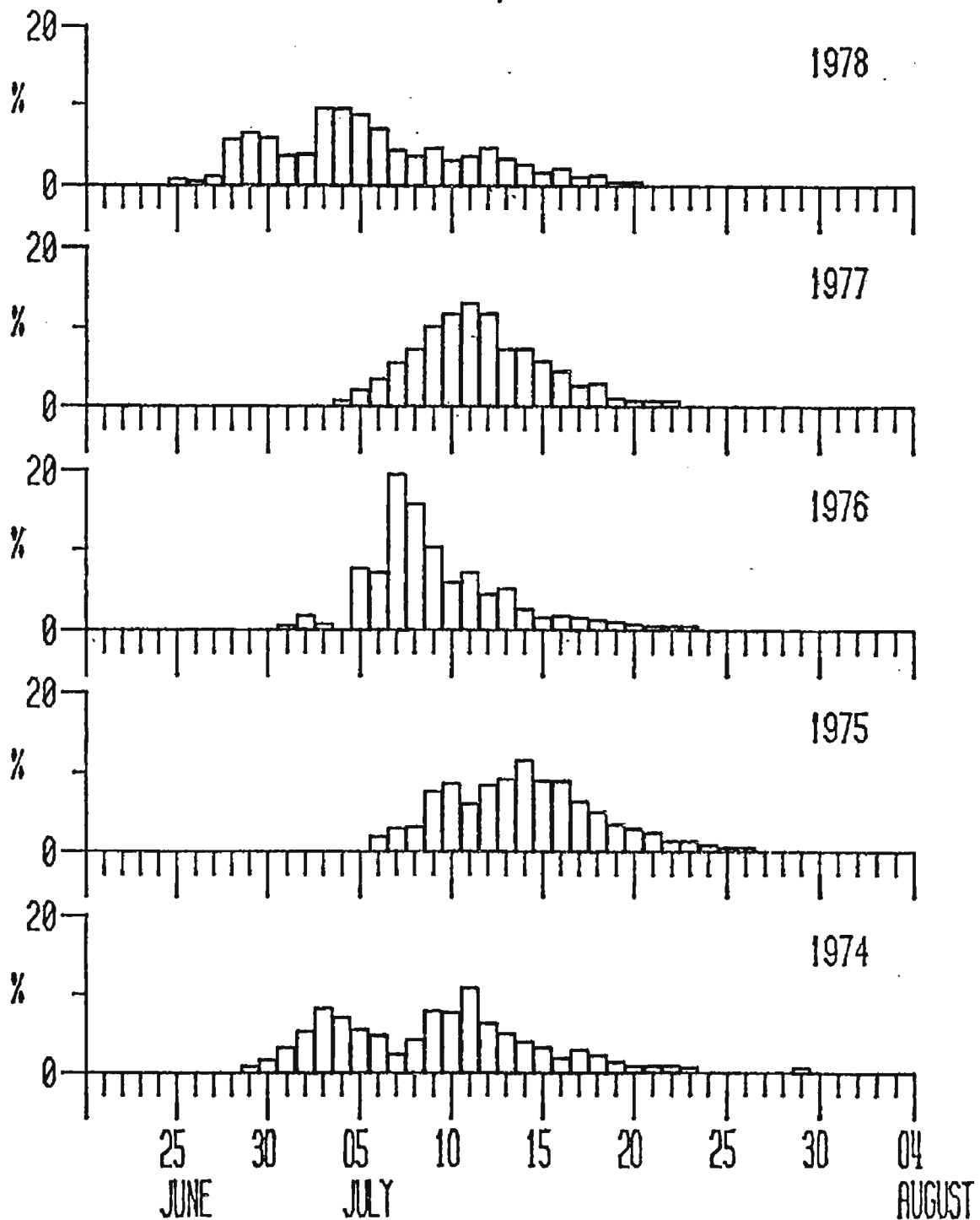
Visual counts during the 1978 season were confined to the hours in which the greatest percentage of the salmon migration had been documented during the base years 1973, 1976, and 1977. Weir counts were terminated on July 21 when net upstream chum and king salmon migration had fallen to very low levels. Sonar counting was discontinued after July 13 due to multiple counting of spawners resulting in unacceptably high counting errors.

Results and Discussion

Summer chum salmon

Timing: The first chum salmon were counted at the tower on June 22 with 34 chums observed over 12 hours of counting. On June 21 six chum were taken in a set gillnet 6 miles downstream from the tower site. The earliest chum sighting in prior years occurred on June 29 in 1977. Chum salmon migration past the tower was unusually early through the 1978 season (Figure 8 and Appendix Table 3). Upstream movement picked up very rapidly starting June 28, and on July 4 the peak daily count for the season of 14,974 fish was recorded. The peak count in 1977 was on July 11, a week later. Ninety-eight percent of the run had arrived by July 18 in 1978 (Appendix Table 4); the 1977 run fell off at a similar rate with the 98% level reached July 21. Extremely early ice free conditions in Norton Sound during the spring of 1978 may have contributed to the unusually early return. Anvik

Figure 8. DAILY MIGRATION PATTERNS FOR CHUM SALMON
ANVIK RIVER, 1974-1978



River water temperatures were not unusually warm. Daily counts in 1978 peaked at lower percentages of the total run than in 1977, 1976, or 1975. In 1976 the daily chum count for July 8 approached 20% of the entire seasonal count. The high daily percent passage in 1978 was approximately 10%.

No direct comparison was made between hourly migration patterns for 1978 and earlier years. Data gathered in 1973, 1976, and 1977 and presented in the 1977 Technical Report (Mauney 1979) showed a relatively consistent pattern of hourly movement. Missing hourly counts for 1978 were subsequently derived from data gathered during those years (see Appendix Table 6).

Abundance: Anvik chum salmon escapement in 1978 above the Robinhood Creek tower is estimated by combining sonar and visual counts made in non-overlapping river transects (Appendix Table 4). Raw sonar counts are presented in Appendix Table 5 for partial day and are expanded to full day counts using data presented in Appendix Table 6. The near bank counting sectors gave the highest chum counts (18%, 21%, 14%, for segments 1, 2, and 3, respectively). Segments 11 and 12 also showed a relatively high rate of counts. The total expanded sonar count was 85,870.

In Appendix Table 4 visual tower counts by river area are summed with sonar counts for a combined total of 150,324 chum. The total west bank counts (85,870 sonar plus 10,275 visual) accounted for 64% of chum enumerated. The tower at mid-stream accounted for 10.4% while the tower at the east bank accounted for 25.6% of chums enumerated. The expanded tower count of approximately 150,000 chum for 1978 was the lowest recorded since the parent year escapement of 201,000 fish in 1974.

Chum escapement for the entire river (Appendix Table 1) in 1978 (upper river sonar and tower enumeration plus lower river aerial) was 224,000 fish. Total escapements for this system for the years 1974 through 1977 have ranged from a high of 843,000 in 1975 to 263,000 for both 1974 and 1977.

Distribution: Spawning distribution of chum salmon within the Anvik River, as indicated by aerial surveys, is presented in Appendix Table 7. Relative distributions above and below the tower site by year are summarized in Table 4. Aerial surveys indicated that 37% of the total escapement in 1978 spawned below the tower. Since 1972 an average of 69% of the documented escapement has been above the tower.

A fair aerial survey was made of the Yellow River, with 21,880 chums counted (Appendix Table 7). In 1976, 38,680 chums were documented in this system.

Table 4. Anvik River chum salmon spawning distributions by year in thousands of salmon.

Year	Aerial count below tower		%	Aerial count above tower		%	Total
1972	138		56	105 ^{1/}		44	243
1973	15		58	11		42	26
1974 ^{2/}	---		--	---		--	---
1975	136		16	707		84	843
1976	168		38	270		62	439
1977	100		38	163 ^{1/}		62	263
1978	74		37	127		63	201
Total	631		31	1,383		69	2,015

^{1/} Tower count used (aerial count at 71,243 low for 1972). No aerial count above tower 1977.

^{2/} No aerial survey completed 1974.

Age, sex, and size composition: Age composition of the Anvik River escapement as indicated by carcass sampling is presented in Table 5. Since 1972, 4₁ age chums have comprised an average of 62% of the sample population. The 1978 Anvik sample of 552 fish was 71% 4₁ and 29% 5₁ salmon. The 1974 return, which was the dominant brood year for the 1978 returns, was also composed mostly of age 4₁ fish (79%). Five-year-old fish have dominated escapements in only 1972 and 1976.

Sex composition of 4,215 chum salmon examined in 1978 was approximately 1:1, male to female. Females were numerically dominant in 1977 and 1976 with respective sex ratios of 1:2.1 and 1:1.6. For 13,439 carcasses sexed during 1975 beach surveys a male/female ratio of 1:1 was found.

Table 5. Age composition of Anvik River chum salmon escapement samples, 1972-1978.

Age	1972		1973		1974		1975		1976		1977		1978		ALL YEARS	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
3 ₁	0	-	48	6	36	9	21	4.6	7	1.1	131	22	1	-	244	6
4 ₁	62	19	605	77	217	79	541	93.6	81	12.9	431	73	390	71	2327	62
5 ₁	253	79	128	16	46	12	22	4.8	537	85.8	22	4	161	29	1169	31
6 ₁	5	2	2	2	1	1	0	0.0	1	0.0	5	2	0	-	16	--
TOTAL	320	100	783	100	302	100	584	100.0	626	100.0	589	100	552	100	3756	100

King salmon

Timing: King salmon were first observed on July 2 in 1978. A peak daily count of 129 individuals was obtained on July 13 (Appendix Table 8 and Figure 9). Ninety-five percent of the run had passed the tower by July 17, approximately a week earlier than in 1977 (Appendix Table 9). Migration timing past the tower for 1978 was one of the earliest on record. The 95% level of counts was not reached until July 28 in 1975. King salmon movement past the tower in 1974 began early (6/24) and counts had peaked by July 10 (king counts were terminated early in 1974 due to high water with the last day of counting July 19). Some in-migration undoubtedly occurred after the termination of the 1978 study but is believed to have been minor.

Based on 24-hour counts conducted in 1973, 1976, and 1977 (combined data) the lowest continuous 6-hour period of king salmon movement is from 2300-0500. With a daily counting schedule totaling 18 hours during the period from July 5 onwards in which king salmon migration peaked, that 6-hour period was deleted from the counting schedule.

Abundance: The 1978 tower count (expanded) of 1,088 kings was the second highest since the project was initiated in 1972. The highest count was 1,260 kings in 1977 (Appendix Table 9). The lowest count for the Anvik was 472 made in 1974 and was probably an incomplete count.

The escapement estimate of Anvik system kings in 1975, 1976, 1977, and 1978 was comprised of the upper river weir, lower river float, and Beaver Creek aerial survey estimates with respective yearly totals of 640, 1,154, 1,362, and 1,324 fish (Table 6). The 1976 estimate included 93 Yellow River kings. A survey of this river in 1977 under poor conditions gave a count of 32 kings. A fair survey of this system in 1978 gave a count of 68 kings.

Distribution: In 1978, 168 kings were counted in a boat survey conducted between the Robinhood Creek site and Beaver Creek on July 7 and 19 (Table 6). Fifty-four kings were counted in 1977 during a boat survey from the Robinhood Creek weir to Beaver Creek on July 29. Counts in this river sector ran 82 and 103, respectively, for 1975 and 1976.

Most documented king salmon spawning occurs within the main Anvik upstream of the Robinhood Creek tower site (average of 86% for years 1975-1978 (Table 6)). Relatively few king salmon have been observed in the major upstream tributaries.

Age, sex, and size composition: Age and sex were determined for 86 carcasses in 1978 (Table 7). Male kings comprised 42% and female 58% of the carcasses examined. For 1977, the dominant age was 62 or 64% of

Figure 9. DAILY MIGRATION PATTERNS FOR KING SALMON
ANVIK RIVER, 1973-1978

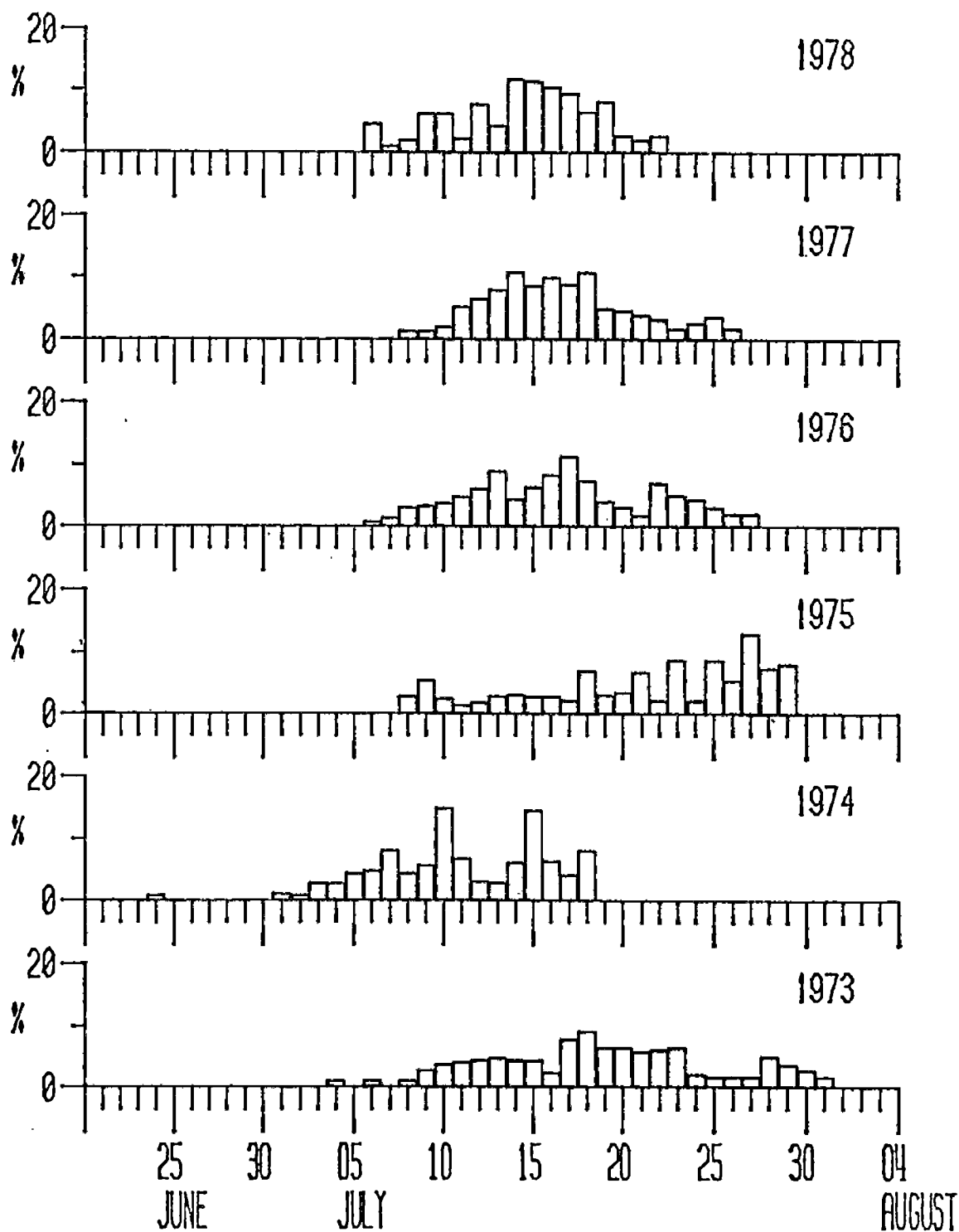


Table 6. Anvik River king salmon escapement distributions as indicated by survey 1975, 1976, 1977, and 1978.

River Area	1975		1976		1977		1978		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Lower Anvik ^{1/}	82	12.8	103	8.9	54	4.0	168	12.7	407	9.1
Beaver Cr. ^{2/}	10	1.6	0	0	15	1.1	-	-	25	0.6
Yellow River ^{3/}	-	-	93	8.1	32	2.3	68	5.1	193	4.3
Upper Anvik ^{4/}	548	85.6	958	83.0	1,261	92.6	1,088	82.2	3,855	86.0
Total	640	100	1,154	100.0	1,362	100.0	1,324	100.0	4,480	100.0

^{1/} Lower Anvik surveys from drifting boat weir site to Beaver Cr. Aerial and drift surveys have shown very few spawning kings below Beaver Creek.

^{2/} Aerial surveys: dates 1978 7/14; 1977 7/16; 1976 7/16; 7/20, 7/21, 7/21; 1975 7/23.

^{3/} Yellow River surveys by aircraft. Counts may not be truly representative of actual numbers in system.

^{4/} Weir count.

those examined and age 5₂ fish represented 28%. In 1978 carcass samples were also predominately 6₂ (68%).

Table 7. Age and sex composition of 1978 Anvik River king salmon^{1/}.

Age	Male		Female		Total	
	No.	% ^{2/}	No.	% ^{2/}	No.	% ^{2/}
4 ₂	13	15	0	0	13	17
5 ₂	10	12	10	12	11	14
6 ₂	13	15	39	45	52	68
7 ₂	0	0	1	1	1	1
Total	36	42	50	58	86	100

^{1/} Data from king salmon carcasses collected in the time period of 7/20-8/20.

^{2/} Percent of ground total.

In 1977 there was good correlation between the frequencies of size categories from carcass samples and those estimated from tower observations. Carcass samples were 54% over 800 mm and 41% 601-800 mm; tower estimates were 49% and 38% for the respective size categories (Table 8).

However, there was a poor correlation in 1978 between estimated and actual king size. In 1978, 63% of those measured were over 800 mm and 24% were 600-799 mm in length. Tower estimates of size were 15% in the former category and 47% in the latter.

Pink salmon

An expanded total of 249 pink salmon was counted past the Anvik tower during 1978 (Appendix Table 10). A record high of 1,366 pink salmon was counted in 1975. Pink salmon tower counts for 1977 totaled 357. Numbers of pink salmon counted tend to be affected by numbers of chum salmon present. Greater numbers of chum salmon passing tend to obscure the pink salmon.

Table 8. Estimated size of king salmon migrating past the Anvik River tower, 1973-1978. Carcass length measurements, 1976-1978.

Year	Estimated Size ^{1/}									
	Under 500mm		500-599mm		600-799mm		Over 800mm		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
1973	19	4.1	46	9.7	112	23.6	297	62.6	474	100
1974	5	1.4	123	34.4	150	41.9	80	22.3	358	100
1975 ^{2/}	16	7.1	59	26.1	80	35.4	71	31.4	226	100
1976 ^{2/}	3	12.0	359	39.0	336	37.0	105	12.0	911	100
1977	29	2.4	128	10.7	448	37.5	593	49.4	1196	100
1978	18	3.0	202	34.2	280	47.4	91	15.4	591	
Carcasses										
1976 ^{3/}	1	2.0	8	16.0	33	66.0	8	16.0	50	100
1977	3	3.0	2	2.0	48	41.0	63	54.0	116	100
1978	0	0	12	13.6	21	23.9	55	62.5	88	100

^{1/} Total length.

^{2/} Does not include salmon seen but not clearly discernible.

^{3/} Lengths mid-eye to fork of tail.

Coho salmon

Aerial surveys were not made of Anvik River coho escapement in 1978.

Acoustic Side Scan Salmon Counter (SSS)

Bendix Electrodynamics Division, in conjunction with the ADF&G, has been developing acoustic adult salmon and smolt counters since 1964. Bendix redesigned existing acoustic fish enumeration systems to produce a single transducer and salmon counter. This Single Side Scanner (SSS) has been described in detail by Menin (1976).

An SSS counter was installed at the Robinhood Creek site in 1978 to document chum salmon escapement. Installation of the unit began on June 24. An artificial substrate was used which consisted of a hydrodynamically modified 8-inch pipe 58 feet long, over which the acoustic beam was directed. A housing on the inshore surface of the artificial substrate was

counting tower (Figure 10). These preliminary studies were continued on July 15, 16, and 17. The objectives of this preliminary reconnaissance were to: (1) determine the distribution of salmon movement across the width of the river, (2) determine the presence of spawning salmon in the local area, and (3) chart spawning beds.

The river was subdivided into sectors the width of which was determined by the extent of visibility; in deep water the sectors were narrow while in shallow water greater distances could reliably be counted (Figure 11). Five sectors were established spanning a total of 227 feet. Counts were made either from an 8-foot tower mounted in a boat or from a convenient tree on the east bank. Sector #1 was 81 feet in width; sector #2, 34 feet; sector #3, 23 feet; sector #4, 27 feet; and sector #5, 62 feet. For purposes of analysis, sectors 2, 3, and 4 were combined as the middle sector - 94 feet in width. An SSS counter would count most of the 81 feet of the west bank (sector), or virtually all of the 62 feet of the east bank (sector 2).

Counts were made of the various sectors by alternating counting times, usually in 15 minute blocks, throughout hours of good daylight. All sectors were allotted equal time for counts. The west sector (No. 1) accounted for 72% of all observed chum salmon movement. Sectors 2, 3, and 4 combined accounted for only 8% of the observed chum movement, while sector 5 accounted for 20% (Table 10). Sectors 1 and 2 accounted for 93% of the king salmon movement, sector 1 - 58% and sector 2 - 35%, respectively.

Table 10. Salmon movement in different sectors of the lower Anvik River, July 1978^{1/}.

	Sector									
	1		2		3		4		5	
	No.	%	No.	%	No.	%	No.	%	No.	%
Chum Salmon										
Date										
7-15	550	63	-6	0	6	1	106	12	212	24
16	470	76	36	6	2	0	10	2	88	16
17	257	89	-5	0	10	3	-19	9	46	8
Total	1,277	72	25	1	18	1	97	6	346	20
King Salmon	18	58	11	35	0	0	2	7	0	0

^{1/} A total of 530 minutes were counted over the 3 days of observation. The average passage rate expanded to fish per hour by date was: 7/15 - 359, 16 - 162, and 17 - 108.

designed to hold the transducer securely. The transducer beam was directed along the surface of the substrate to a metal target located at the opposite end of the substrate.

By June 25, 1978 adequate numbers of chum salmon were passing for basic calibration to be completed and satisfactory test counts made. Daily comparisons of side scanner and visual counts began on July 2 and continued through July 13 (Table 9). Spawning activity in the vicinity of the artificial substrate had increased to the point that salmon were counted over and over because of their milling over the substrate. Efforts were made to drive spawners away from the artificial substrate with little lasting success. Sonar counts were subsequently terminated.

The sonar count exceeded the tower count by 24% if days of spawner interference are included. If only days of no spawner interference are considered the visual count was 8,502 and sonar 8,721, a 3% error (Table 9).

Suspected counts (extremely high compared to adjacent sectors) in any 5-foot counting sector were discarded as erroneous. To arrive at an approximation of the true count during the discarded period, an interpolation was used based on count activity in adjacent sectors during the same time period, or on counts obtained in the same sector immediately before and after the erroneous count. Occasionally, sector 1 or 12 (the nearest shore and last sector, respectively) had erroneous counts in which case it was assumed that sector 2 approximated sector 1 for that time period and sector 11 approximated sector 12.

Interpolation and expansion after the season was similar to that used with counting tower data. Sonar counts for each day were tabulated by sector by hour using only hourly counts for which acceptable data was available (Appendix Table 5).

The daily expanded count was then computed by interpolating missing counts with a simple arithmetic process based upon past salmon passage rates during missing hours.

Season Total Count = Sum of Daily Counts 6/25 - 7/13 = 85,870

Season Sector Counts may then be computed:

Season total expanded count x % by sector for season (Appendix Table 5). Example: Sector 1 $85,810 \times 18.2 = 15,628$

Daily Sector Counts may then be computed:

Expanded daily counts x % by sector for season (Appendix Table 5). Example: 6/25 sector 1 $642 \times 2.1 = 13$

Table 9. Comparison of visual with sonar counts of chum salmon, Anvik tower, 1978.

Date	Hours Counted Visually	Total Counts		% deviation from visual
		Visual Counts <u>1/</u>	Sonar Counts	
7/2	1.50	176	184	+ 5
7/3	2.50	523	787	+ 50 <u>2/</u>
7/4	.75	138	157	+ 14
7/5	.66	177	449	+134 <u>2/</u>
7/6	5.08	532	1,539	+189 <u>2/</u>
7/7	7.33	622	1,250	+101 <u>2/</u>
7/8	8.46	966	860	- 11
7/9	10.00	2,359	2,298	- 3
7/10	7.75	962	1,016	+ 6
7/11	6.66	1,014	1,050	+ 4
7/12	10.00	2,887	3,156	+ 9
7/13	.37	30	100	+233 <u>2/</u>
Total	61.06	10,386	12,846	+ 24

Visual Counts vs. Sonar Counts Total
Excluding times when spawners present

	Hours Counted	Visual <u>1/</u> Counts	Sonar Counts	Percent <u>3/</u> Accuracy
Total	45.12	8,502	8,721	103%

1/ Assume visual counts approach 100% accuracy although probably slightly undercount actual upstream movement. Visual counts are just those moving upstream, i.e., the net count not considering downstream movement.

2/ Spawners present resulting in false counts.

3/ Calculated by dividing sonar count by visual counts.

The following is a listing of some of the causes of erroneous counting data.

1. False counting due to:
 - a. Dead range setting incorrect, counts generated from transducer housing;
 - b. Active range setting too far, counts target;
 - c. Transducer is aimed too low, counts substrate echoes;
 - d. Debris on the substrate triggers count; and
 - e. Transducer is aimed high, counts generated from water surface triggering more than one count.
2. Multiple counting due to:
 - a. Fish passing slowly through the beam;
 - b. Sensitivity is set too high - counts triggered from non-salmon target; and
 - c. Spawning activity near the substrate or on it.
3. Machine malfunction or operators mistake:
 - a. Printer malfunction (will delete some sectors); and
 - b. Clearing memory before printing.
4. Other:
 - a. Bow in substrate, fish passing beneath substrate; and
 - b. Fish avoiding substrate by moving around end.

For further discussion of SSS counter and substrate installation operation and calibration, see Namtvedt et al. (1979).

Sonar Site Evaluation

On July 13, 1978 a proposed sonar site, 3 miles below Theodore Creek, was evaluated by making visual salmon counts from a makeshift

Figure 10. Proposed Lower Anvik River sonar sites three miles below Theodore Creek, 1978.

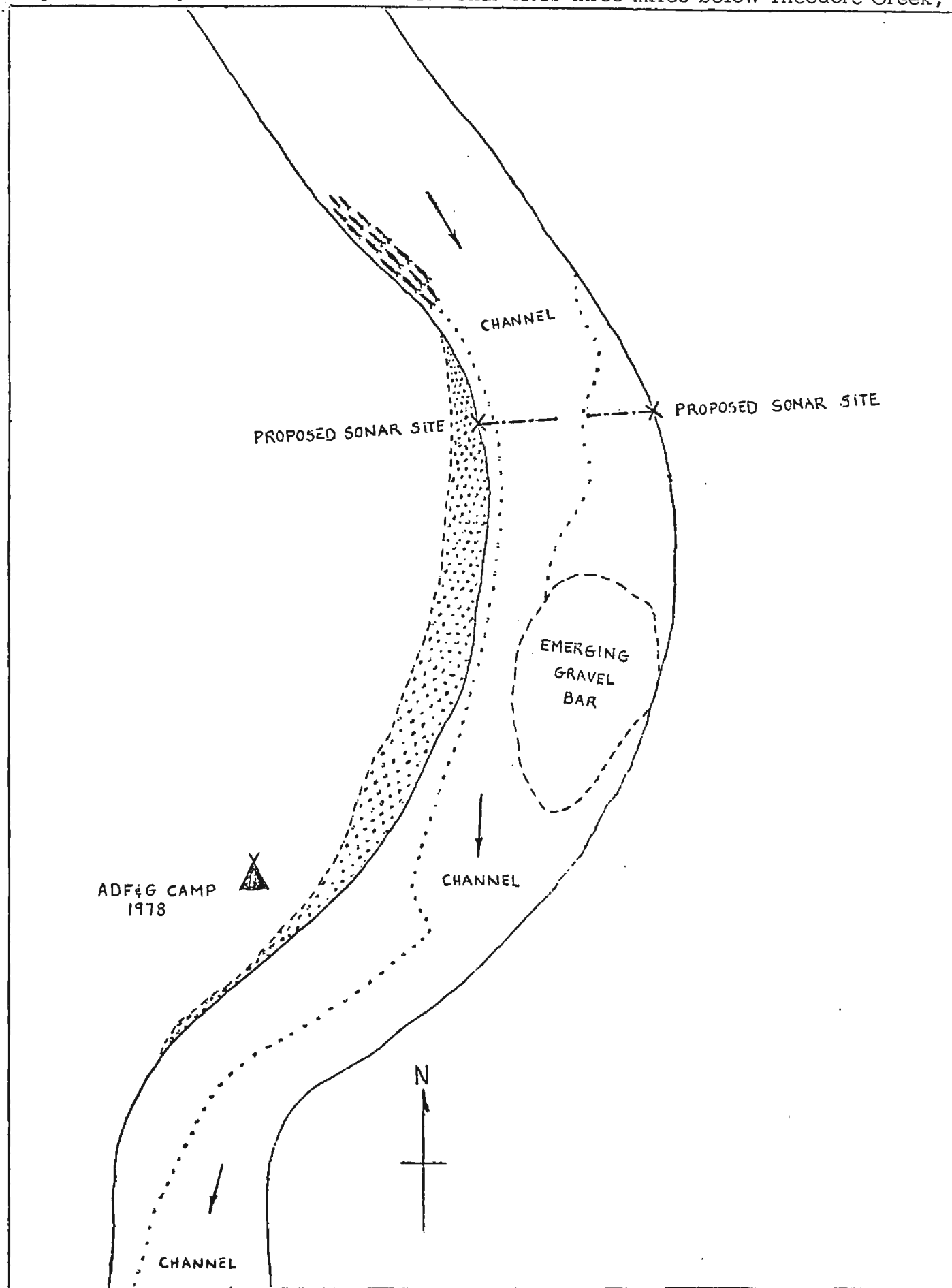
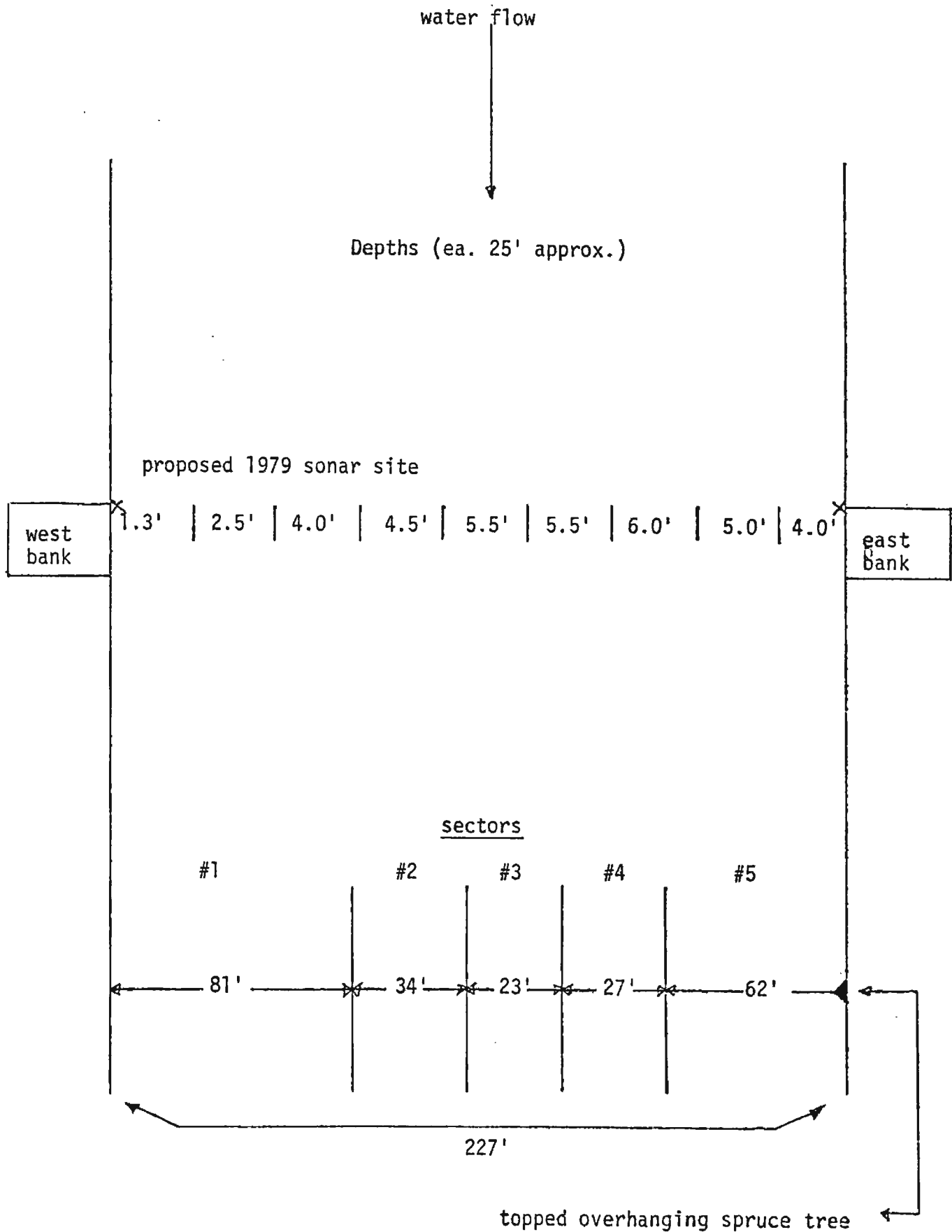


Figure 11.
Lower Anvik River--Counting sectors and water depths at the proposed new sonar site---1978.



Approximately 90% of the chum salmon will apparently be enumerated by installing SSS counters along the east and west banks. On the basis of this data it appears that coverage may be achieved of most of the Anvik run at this site by sonar. An area of chum salmon spawning was found 100-200 feet upstream from the proposed installation site, but counts due to milling at the site should be minimal.

During the 1979 initial field season visual correlation counts will be made of chum salmon along with sonar counts at this site. King salmon will also be enumerated.

Summary

The total expanded Anvik tower count of 150,000 summer chums was the lowest since the parent year escapement of 201,000 fish in 1974. The count for the entire river including the Yellow River, was 229,000 chums. The run was one of the earliest on record.

In 1978, 44% of the chum escapement observed during aerial surveys was above Robinhood Creek with 56% below. Since 1972, an average of 69% of documented escapement has been above the tower.

Carcass sampling indicated that in 1978 the ratio of female to male chums was approximately 1:1. Age composition of chum salmon was 71% 4₁; 29% 5₁.

The total Anvik River king count in 1978, including the Yellow River was 1,324 fish. This was a record level of documented escapement for this system essentially equaling the 1977 escapement of 1,362 kings.

Most of the king salmon spawning observed with the Anvik system has been in the main Anvik River above Robinhood Creek and in the Yellow River.

The sex ratio of 77 king salmon carcasses examined in 1978 was approximately 1:1. The predominant age class represented was 6₂ (68%). Sixty-three percent of the king salmon carcasses measured were above 800 mm in mid-eye to fork length.

Preliminary reconnaissance surveys of the proposed lower Anvik sonar site indicate that it should be very suitable for chum salmon run documentation.

MID-YUKON RIVER FALL CHUM SALMON TAGGING

Introduction

As part of a statewide stock separation study, additional State funds became available July 1, 1976 to conduct a 3 year tag-recovery program of Yukon River fall chum salmon. The objectives have been as follows:

- (1) Determine the timing of separate stocks through the fishery,
- (2) Determine the pathways of movement of separate stocks through the fishery,
- (3) Determine the relative contribution of major spawning stocks to the fishery, and
- (4) Estimate population size and exploitation rate of the major stocks.

Methods and Materials

Fishwheels of the standard large Yukon design were contracted from fishermen to capture fall chums for tagging. Continuing the tagging of 1976 and 1977, four fishwheels were contracted in 1978 and were located from mile 601 to mile 725 along the Yukon River (Figure 12). Fishwheel No. 1 was stationed on the north bank of the main Yukon 30 miles upstream from the village of Tanana which is located at the confluence of the Yukon and Tanana Rivers (Yukon No. 1 north, River Mile 725). Fishwheel No. 2 was fished on the south bank of the Yukon 1 mile downstream from No. 1 (Yukon No. 2 south, River Mile 274). Fishwheel No. 3 was located on the north bank of the Yukon in the vicinity of Tanana Village (Yukon No. 3 north, River Mile 695). Wheel No. 4 was situated on the south bank of the Yukon about 20 miles upstream from Ruby which is located about 94 miles below the confluence of the Tanana and Yukon River (Yukon No. 4 south, River Mile 601).

In 1976, two weeks were utilized for tagging (one on each bank) near Galena south of Ruby (River Mile 555N and 540S) and in 1977 these two wheels were used again along with a third wheel 20 miles above Ruby.

One-inch diameter Petersen disk tags were used in all tagging, and a \$2.00 reward was offered to the public for each returned tag. Persons returning tags were asked to supply the date, location, and method of recovery.

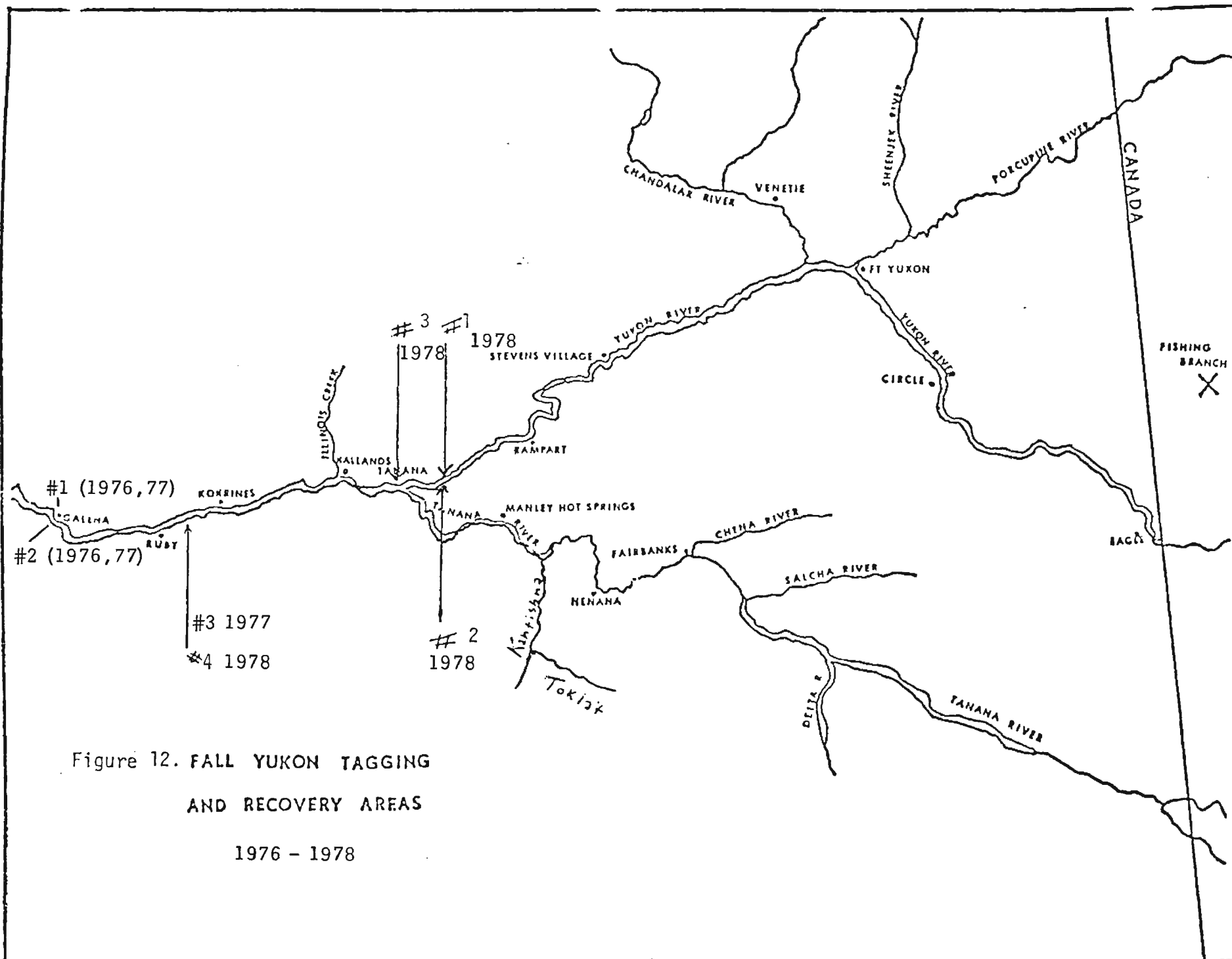


Figure 12. FALL YUKON TAGGING
AND RECOVERY AREAS

1976 - 1978

In 1978, to allow ready field separation as to tagging location, Ruby, south bank tags (wheel 4) were yellow in color. Tags used at all other sites were orange in color. Actual tagging began at the Tanana Village (wheel 3) and Ruby fishwheels on August 1 and concluded at the Tanana Village wheel on September 22.

Base camps were established within the immediate vicinity of each fishwheel. Communication was maintained between camps by radio. As the season progressed, daily fishwheel catches were used by management personnel as an index to run strength in making decisions regarding commercial fishing openings upriver. Communication of catch results to headquarters was accomplished by radio or by telephone from Ruby.

Detailed tagging procedures and recovery operations were listed in the 1976 Annual Technical Report (Mauney 1977). Numbers of other fish species in fishwheel catches were recorded by date of capture. Tag recovery efforts were undertaken in the Sheenjek, Toklat, Delta, and Fishing Branch Rivers (Figure 12). Tags were recovered from carcasses or from spawning fish retrieved by means of spear or shotgun. Spawning ground observations included:

- 1) The ratio of tagged to untagged fish,
- 2) Tag recoveries by date, and
- 3) Air and water conditions and temperatures.

Carcasses and living fish were sampled in the Sheenjek, Fishing Branch, Toklat, and Delta areas throughout the period of on-site investigations. Data taken included sex and length (mid-eye to fork of tail). Scale samples were taken for later age determination and analysis.

Results and Discussion

Catches and tagging 1978

During 1978, a total of 9,668 chum salmon and 124 coho salmon was tagged (Appendix Tables 11 and 12). At the main Yukon Wheel No. 1, 2,309 chum were tagged, main Yukon Wheel No. 2, 1,956; Tanana Village Wheel 3, 2,945; and Ruby No. 4, 2,728. Not all captured salmon taken in the respective wheels were tagged. Crews were directed to allocate tagging effort throughout the run period with a maximum of 2,000 chums to be tagged each at wheels 1 and 2, and 3,000 chums each at wheels 3 and 4. Also, only fish in good physical condition were tagged; some fish were inadvertently injured or killed during capture by fishwheel. Total chum catches in 1978

were 3,161, 2,363, 4,156, and 3,245 for wheels 1, 2, 3, and 4 (% tagged 73, 83, 71, and 84, respectively). In 1978 of 124 coho caught, 97 or 78% were tagged at the Ruby site.

Catch success can only be directly compared between years at the Ruby wheel. A total catch of 3,245 chum was recorded at this site in 1978; 2,567 were captured in 1977 (Appendix Table 13). However, in 1978 the wheel used was a three basket model while the wheel used at this site in 1977 only fished two baskets. The three baskets model undoubtedly had an increased catch potential of some unknown magnitude.

Catches of non-salmon species captured by fishwheel of tagging are listed in Appendix Table 14. Catches of other species included sheefish (Stenodus leucichthys nelma), broad whitefish (Coregonus nasus), hump-back whitefish (Coregonus pidschian), round whitefish (Prosopium cylindraceum) and least cisco (Coregonus sardinella). Ten of the sheefish captured were tagged. A total of 11 king salmon were also tagged in 1978.

Chum catches at the Ruby wheel (Yukon No. 4) peaked later in 1978 than in 1977 (Figure 13). As expected, the Ruby or south bank wheel was behind the other sites in cumulative catch percentage reflecting the later timing of Tanana River runs (Figure 14).

Of 9,668 chum tagged in 1978, 5,034 were identified as male and 4,623 were identified as female (or 52% and 48%, respectively).

Rate of tag returns by tagging site, recovery site, year, and sex

Since publication of the 1977 Annual Technical Report additional recoveries have come in from the 1976 and 1977 tagging. Recoveries of 1977 chum tags through September of 1978 were 2,015 or 38% of those at large (Table 11). Percent recovery by location of tagging for Galena north, Galena south and Ruby south have totaled respectively 46, 35, and 33%.

Through December of 1979, 4,744 or 49% of the chum salmon tagged in 1978 and released had been recovered. Tag recovery rates ranged from 32% for chums tagged at the Ruby site to a high of 57% for chums tagged at both the upper Yukon No. 1 and 2 fishwheels (Table 11). Recoveries of Ruby tags were significantly lower than expected as compared to the other sites in 1978 (Table 12). Coho recoveries through this date have totaled 46 or 37%.

This difference in the ratio of observed and expected returns by site of tagging may be explained in part by differences in the allocation of fishing

Figure 13. Daily capture of chum salmon at Ruby fishwheel (1977 and 1978).

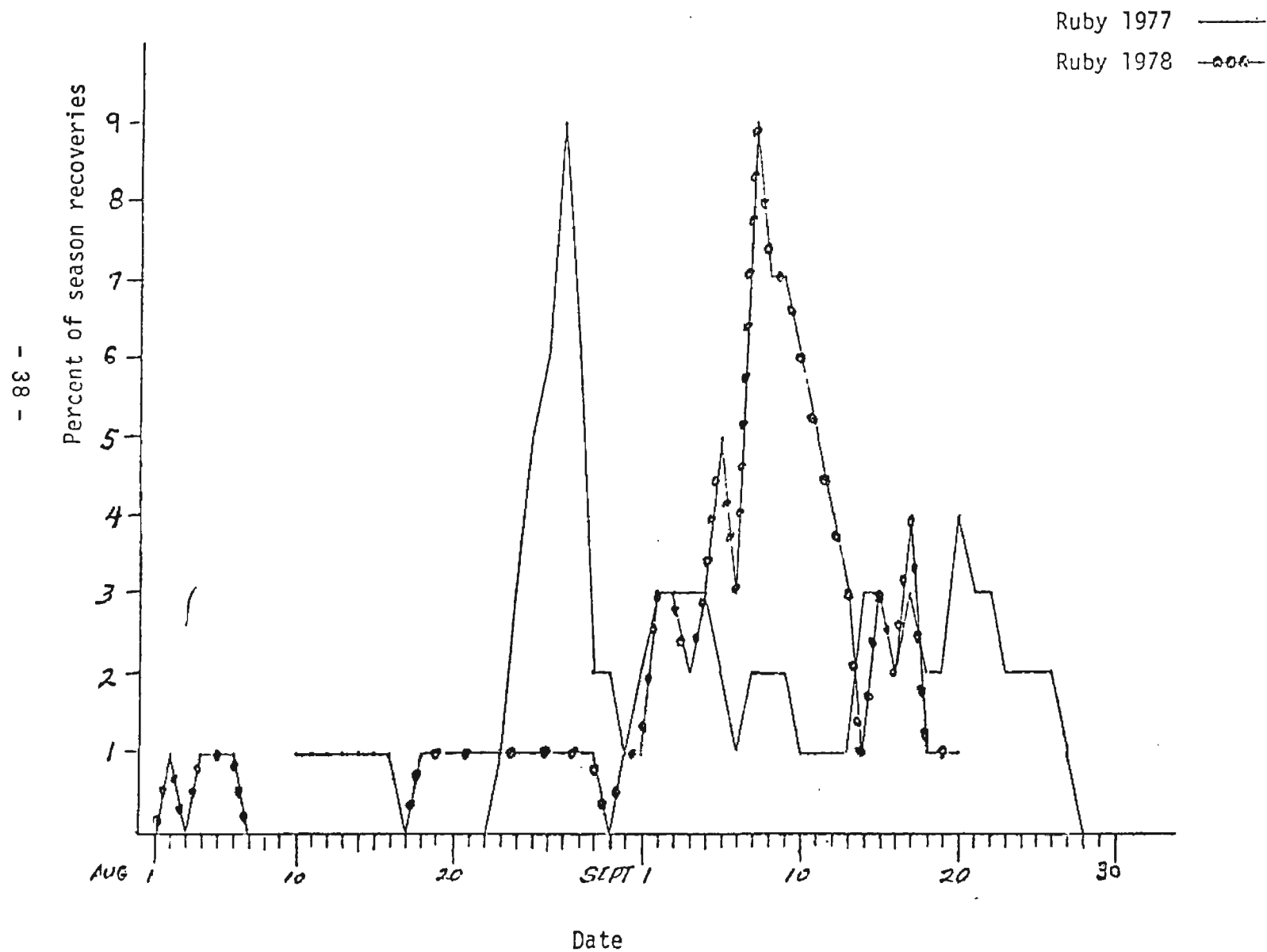


Figure 14. Percent of total Yukon chum salmon tag recoveries by major village areas, 1976-1978.

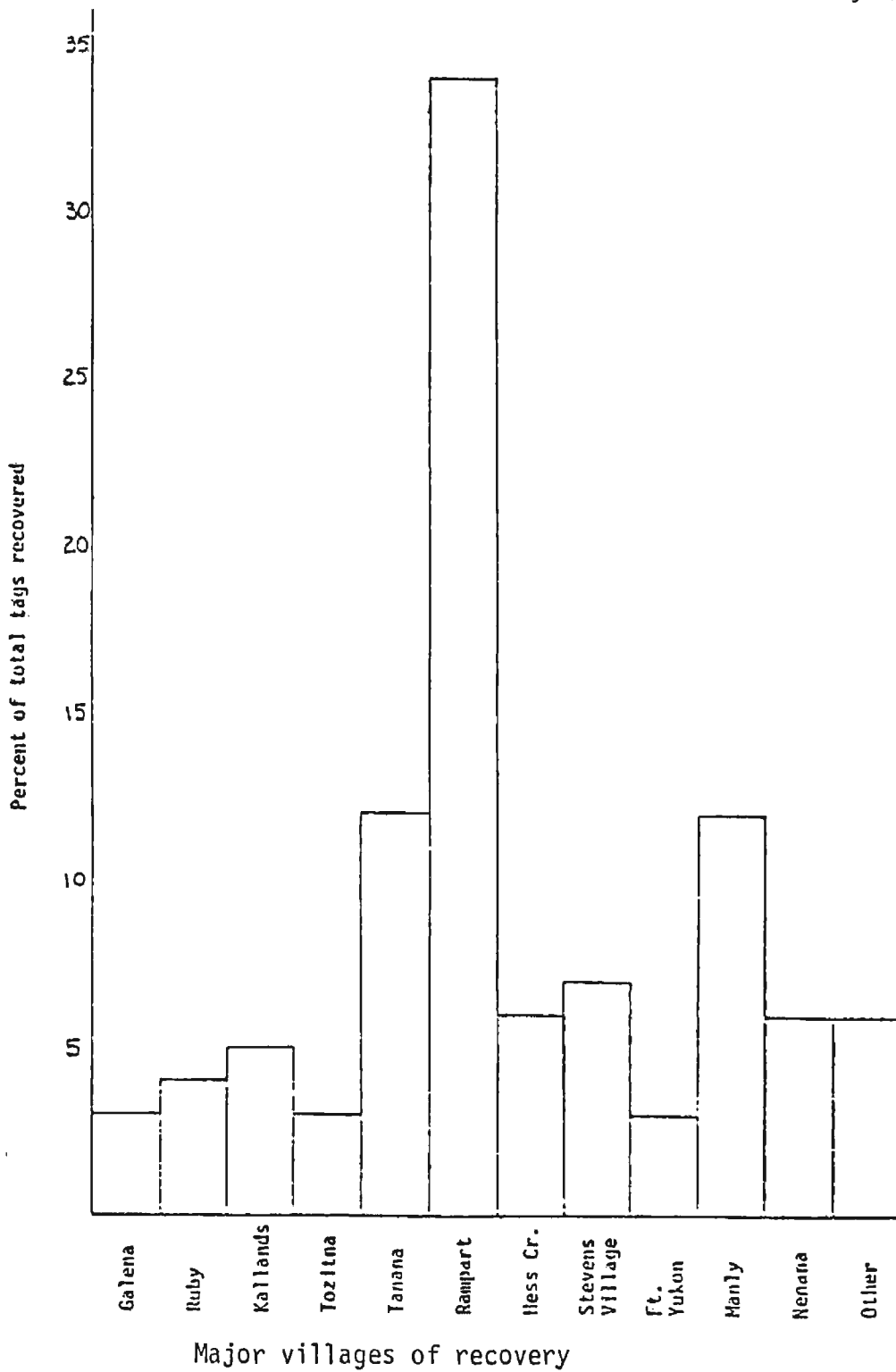


Table 11. Numbers of chum salmon tagged and recovered by site of tagging and year. 1/

Tagging Location	1976			1977			1978			Total		
	No. Tag	No. Recov.	%	No. Tag	No. Recov.	%	No. Tag	No. Recov.	%	No. Tag	No. Recov.	%
Galena North	545	248	46	1,841	841	46	-	-	-	2,386	1,089	46
Galena South	672	365	54	1,208	423	35	-	-	-	1,880	788	42
Ruby South	-	-	-	2,308	751	33	2,728	875	32	5,036	1,626	32
Tanana Village N.	-	-	-	-	-	-	2,945	1,581	54	2,945	1,581	53
Upper Yukon N.	-	-	-	-	-	-	2,039	1,167	57	2,039	1,167	57
Upper Yukon S.	-	-	-	-	-	-	1,956	1,121	57	1,956	1,121	57
Total	1,217	613	50	5,358	2,015	38	9,668	4,744	49	16,243	7,372	45

1/ Returns of 1976 and 1977 revised through December 1, 1978. Data for 1978 is through December 1, 1979.

2/ River mile from mouth of tagging sites: Ruby south - 601; Tanana Village - 695; Yukon Upper South - 724; Upper Yukon North - 725.

Table 12. Observed versus expected^{1/} numbers of tagged chum salmon recoveries by fishwheel of tagging for 1978^{2/}.

Tagging site	Number tagged	Recovered		Expected	
		No.	%	No.	%
Yukon north	2,039	1,167	57	1,002	49
Yukon south	1,956	1,121	57	962	49
Tanana Village	2,945	1,581	54	1,443	49
Ruby south	<u>2,728</u>	<u>875</u>	<u>32</u>	<u>1,337</u>	<u>49</u>
All sites	9,668	4,744	49	4,744	49

^{1/} Expected recovery = $\frac{\text{Number tagged at given site}}{\text{Total number tagged}} \times \text{total recoveries}$

^{2/} Does not include spawning ground recoveries of 99 fish.

effort and run strength. On the basis of tag recoveries from the 1976 and 1977 tagging, upper Yukon, Porcupine stocks migrate along the Yukon north bank and support the bulk of the fall harvest for Tanana, Rampart, Hess Creek, and Stevens Village which are largely along the north bank (Mauney 1977). The south bank run has been demonstrated through tagging to be largely Tanana spawning stock and comprises the bulk of Manley, and Nenana catches. The harvest percentage by major area of harvest is given in Figure 15 and Table 13. Major recovery areas and percent recovery by wheel were as follows: Wheel 1 Rampart Rapids, 34% - Rampart Village 21%, Wheel 2 Rampart Rapids, 35% - Rampart Village, 26%; Wheel 3 Rampart Rapids, 26% - Rampart Village, 21%; and Wheel 4 Manley Hot Springs, 41% - Kallands, 12% - Tozitna, 12% - Nenana, 11%. Fish tagged at Yukon N and S wheels, No. 1 and 2, respectively, were not expected to be available for harvest in other than upper Yukon fisheries.

Through January of 1979 41 coho or 37% of those tagged had been recovered.

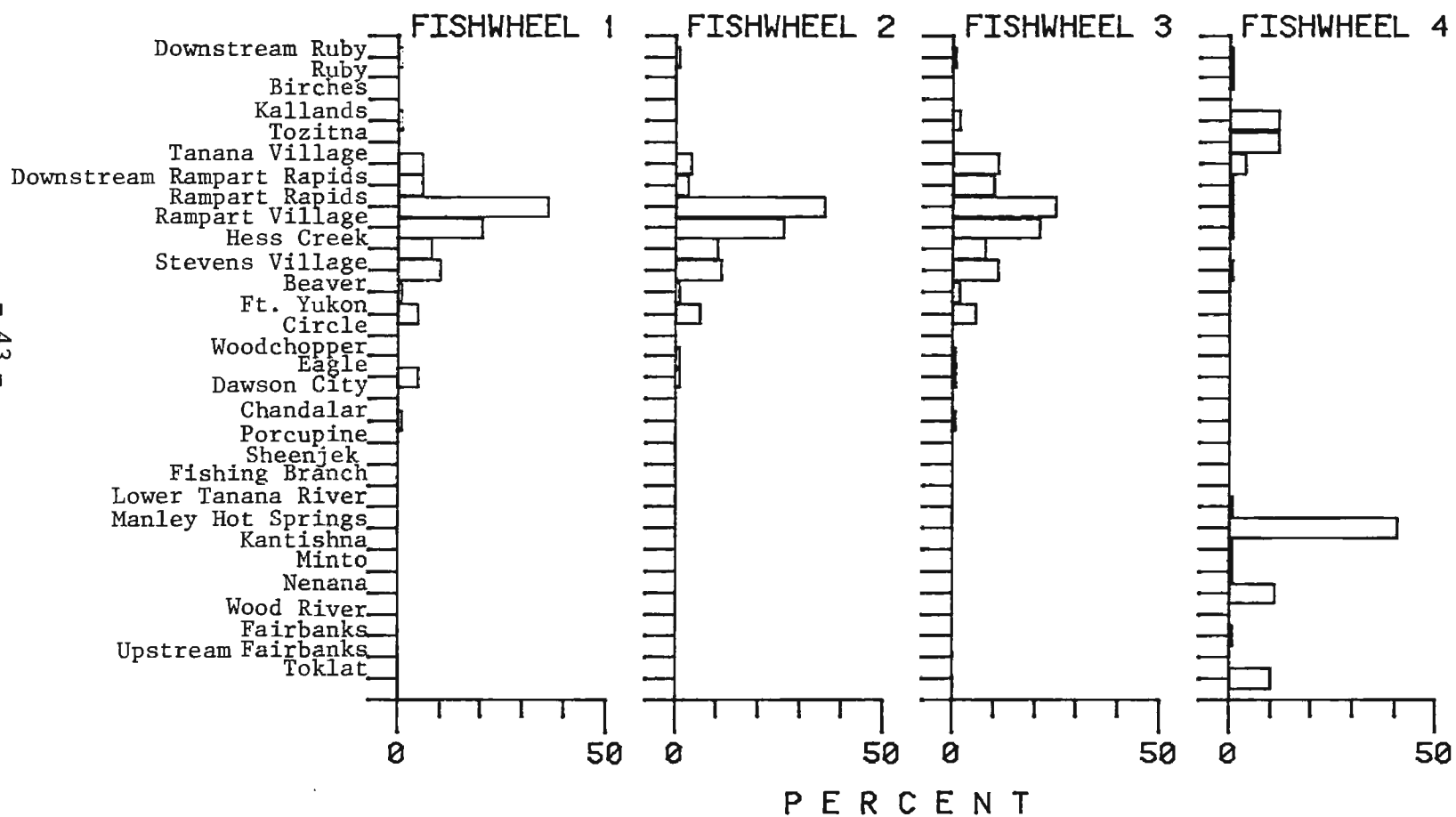
Tag returns by method of recovery and fishing activity

The commercial fishery accounted for approximately 62% of the tag recoveries in 1976, 30% in 1977, and 56% in 1978. Subsistence fisheries accounted for 30%, 56%, and 44% of the recoveries for those respective years. Overall, for the 3-year study period, commercial recovery of tags has amounted to 52% and subsistence recovery 48%. The commercial quota of 250,000 fall chum was not easily attained in 1976 by the fishery due to the small size of the run. Most of the chum catch was, therefore, sold commercially. The substantially stronger 1977 run resulted in commercial quotas being quickly attained with a larger percentage of the 1977 harvest thus available for the satisfaction of subsistence needs. Subsistence caught salmon eggs were legally sold in 1977. This sale may have motivated some individuals to catch salmon in excess of their actual needs. The 1978 upper Yukon fall chum return was only moderate in size and harvests were predominantly channeled into commercial outlets.

Little difference between years was noted in the capture rate of different gear of upper Yukon tagged salmon. The fishwheel has historically been the primary gear used in upper Yukon fisheries and has accounted for 60% of the tag recoveries during this study. Gillnets have accounted for 31% of project tags recovered. Spawning ground recoveries, made by-and-large by Fish and Game crews, have accounted for 3% of the recoveries.

Tagged coho recoveries by fishery and gear have followed in general the same pattern seen for chum recoveries.

FIGURE 15 PERCENT OF YUKON CHUM SALMON TAG RECOVERIES
LOCATION OF RECOVERY BY FISHWHEEL TAGGED, 1978



Stock separation by pathways of migration

Fall chum recoveries by major area of recovery for 1976, 1977, and 1978 are presented in Table 14. Only tags identified as to spawning destination are presented in this table. In 1978 insufficient numbers of spawning ground recoveries were made from Yukon 1 north and Yukon 2 south wheels of tagging to give an indication of distinct migratory pathways for upper Yukon - Porcupine stocks. For purposes of analysis, salmon recovered in the Yukon above the Tanana-Yukon confluence (Mile 695) are regarded as upper Yukon River stocks. Salmon recovered in the Tanana above this confluence are regarded as Tanana River stocks.

Recoveries from north bank fishwheel sites in the upper Yukon areas above the Tanana confluence for 1976, 1977, and 1978 (fishwheel 3 north only - fish tagged at wheel numbers 1 and 2 during 1978 would be expected to be recovered in upper Yukon) were 77, 94, and 99%, respectively. Overall, 97% of the recoveries from the north bank wheels above the Tanana confluence and thus identified as to river system, were recovered in the upper Yukon.

Eight-six percent of the tag recoveries from the Galena south bank wheel in 1976 and 89% of the recoveries from the Galena and Ruby south wheels in 1977 were recovered within the Tanana system. The percentage in 1978 from the Ruby south bank wheel was 93. For all years combined out of 1,109 recoveries of south bank tagged chums recovered above the Tanana confluence, 1,009 or 91% were recovered within the Tanana system.

Based on the 3 years of tagging in the Galena, Ruby, and Tanana village areas, it appears that chum salmon migrating up the north bank of the Yukon from the Galena village area upstream can be regarded as upper Yukon stocks, while those migrating up the south bank of the Yukon from the Galena area upstream can be regarded as Tanana stocks.

Most documented coho spawning in the upper Yukon drainage has been within Tanana tributaries. Catches by project fishwheels show that most coho follow the south bank. Tag returns support this with 86% of the tag returns (46 recoveries) coming from the Tanana system. Returns, therefore, indicate that coho as well as chum become bank oriented well downstream from the Tanana confluence. Low catches of coho at the Galena south bank site in 1976 and 1977 with high catches at the Ruby south bank site may indicate that salmon migratory patterns in respect to proximity to the bank alter from one river location to another; or that coho may become more closely bank oriented as they approach the further upstream sites nearer the Tanana confluence. There is evidence from tagging that Delta River chum salmon may also behave in this manner.

Table 13. Fall chum salmon recoveries by river location and wheel of tagging, 1978.

Location	Wheel 1	Wheel 2	Wheel 3	Wheel 4
Downstream Ruby	15	7	10	8
Ruby	1	1	0	6
Birches	1	0	0	1
Kallands	10	4	23	98
Tozitna	1	3	4	99
Tanana Village	64	44	164	36
Downstream Rampart Rapids	62	35	159	8
Rampart Rapids	424	369	397	77
Rampart Village	240	271	315	14
Hess Creek	101	111	125	0
Stevens Village	117	130	169	7
Beaver	9	13	28	0
Ft. Yukon	62	61	87	2
Circle	3	1	1	0
Woodchopper	1	9	9	0
Eagle	7	8	16	0
Dawson City	1	5	8	0
Chandalar	14	5	8	0
Porcupine	2	5	2	0
Sheenjek	3	1	2	0
Fishing Branch	0	1	0	0
Lower Tanana River	0	0	0	7
Manley Hot Springs	2	2	7	348
Kantishna	0	0	0	9
Minto	0	0	1	12
Nenana	0	2	3	90
Wood River	0	0	0	2
Fairbanks	1	0	0	8
Upstream Fairbanks	0	0	0	1
Toklat	0	0	0	88

*All recoveries
below Galena
recorded
here? 1.*

Table 14. Yukon chum tag recoveries by bank of tagging, river mile and year.

Recovery Area 2/	North Bank Tagging 1/							
	1976		1977		1978		Total	
	No.	%	No.	%	No.	%	No.	%
Upper Main Yukon								
Downstream Rampart Rapids	5	5	84	17	159	12	248	13
Rampart Rapids	10	10	90	19	397	30	497	26
Rampart Village	38	39	151	31	315	24	504	26
Hess Creek	11	11	29	6	125	9	165	9
Stevens Village	3	3	38	9	169	13	210	11
Beaver	0	0	0	0	28	2	28	1
Ft. Yukon	2	2	16	3	87	7	105	5
Circle	2	2	2	-	1	-	5	1
Woodchopper	0	0	5	1	9	-	14	-
Eagle	1	1	12	2	16	1	29	2
Dawson City	1	1	12	2	2	-	15	1
Chandalar	2	2	4	1	8	-	14	-
Porcupine	0	0	5	1	2	-	7	-
Sheenjek	0	0	3	1	2 ✓	-	5	1
Fishing Br.	1	1	1	-	3 ✓	-	5	1
Subtotal	76	77	452	94	1,320	99	1,848	97
Tanana								
Lower Tanana	0	0	0	0	0	0	0	0
Manley Hot Spgs	9	9	11	2	7	-	27	1
Kantishna River	12	12	0	0	0	0	12	-
Minto	0	0	2	-	1	-	3	-
Nenana	0	0	14	2	3	-	17	1
Wood River	0	0	1	-	0	0	1	-
Fairbanks	0	0	0	0	0	0	0	0
Upstream Fairbanks	0	0	0	0	0	0	0	0
Toklat	1	1	2	-	0	0	3	-
Delta	0	0	1	-	0	0	0	1
Subtotal	22	23	30	6	11	1	63	3
Total	98	100	482	100	1,331	100	1,911	

Table 14. Yukon chum tag recoveries by bank of tagging, river mile and year (continued).

Recovery Area <u>3/</u>	South Bank Tagging <u>2/</u>							
	1976		1977		1978		Total	
	No.	%	No.	%	No.	%	No.	%
Upper Main Yukon								
Downstream								
Rampart Rapids	3	2	5	2	8	2	16	2
Rampart Rapids	2	1	6	2	11	2	19	2
Rampart Village	8	5	8	3	14	2	30	3
Hess Creek	1	1	7	2	0	0	8	1
Stevens Village	1	1	5	2	7	1	13	1
Beaver	3	2	0	0	0	0	3	-
Ft. Yukon	0	0	2	1	2	-	2	-
Circle	0	0	0	0	0	0	0	0
Woodchopper	0	0	0	0	0	0	0	0
Eagle	1	1	0	0	0	0	1	-
Dawson City	0	0	0	0	0	0	0	0
Chandalar	0	0	0	0	0	0	0	0
Porcupine	0	0	0	0	0	0	0	0
Sheenjek	0	0	1	-	0	0	1	-
Fishing Branch	1	1	0	0	0	0	1	-
Subtotal	24	14	34	11	42	7	100	9
Tanana								
Lower Tanana	0	0	2	1	7	-	9	1
Manley Hot Spgs	52	31	110	35	359	57	521	47
Kantishna R.	58	35	4	1	9	1	71	7
Minto	0	0	4	1	13	2	17	2
Nenana	0	0	61	19	95	15	156	14
Wood River	3	2	0	0	2	-	5	-
Fairbanks	3	2	1	+	9	1	13	1
Upstream Fairbanks	0	0	1	-	1	-	2	-
Toklat	27	16	81	26	88✓	14	196	18
Delta	1	-	18	6	0	0	19	2
Subtotal	144	86	282	89	583	93	1,009	91
Total	168	100	316	100	625	100	1,109	100

1/ North bank tagging locations by river mile and year: 1976, 555; 1977, 555; 1978, 695.

2/ South bank tagging locations by river mile and year: 1976, 540; 1977, 540 and 601; 1978, 601.

3/ For areas see codings computer runs AYK files.

Spawning grounds investigations

Numbers of tagged chum salmon observed during spawning grounds reconnaissance trips are given in Table 15. Tags have been recovered at as high a rate as 1 per every 100 chums observed on the Toklat during 1978 to a low rate of 1 to 12,000 on the Fishing Branch in 1977.

The lack of tag recoveries from Sheenjek, Fishing Branch, and Delta spawning areas could be attributed to a number of factors: (1) Failure to initially tag these stocks at the same rate as other stocks due to different migration pathways such as along mid-river sandbars, (2) selective fishing mortality removed a higher percentage of the tagged upper Yukon stock leaving relatively fewer tagged fish to escape than in the Tanana, (3) failure to spot tagged salmon during recovery efforts, (4) differential predation of tagged fish before recovery, and (5) differential rates of tag shedding.

Lister and Harvey (1969) have shown that survival and spawning success of chum salmon tagged with the Petersen disc is not adversely affected, and that tags lost by shedding during spawning averaged 16% of the total tagged for both sexes. Combined observations by ADF&G tagging crews indicated that there was some shedding of tags in the main river by salmon recaptured in study wheels.

The age composition of the fall run has averaged 71% 4₁ (Appendix Table 15). Other age categories represented include 3₁ and 5₁. Toklat fall chums have shown the highest percentage age 3₁ at 39% (years 1974, 1976-1978) of any upper Yukon spawning stock. Sheenjek carcasses sampled in 1976 ran an unusually high 54% 5₁.

Run timing and rate of movement

According to the observations of Yukon area fishermen, the north bank catches generally peak earlier than south bank catches. This pattern was in general verified by the 1976, 1977, and 1978 tagging effort (Mauney 1979). Data discussed above has shown that the north bank catch upstream of Galena is composed largely of upper Yukon-Porcupine stocks; the south bank catch upstream of Galena to the Tanana confluence is composed largely of Tanana stocks.

Most of the upper Yukon stocks passed the Galena area as many as 9 days prior to the passage of a corresponding level in the Tanana stocks in 1976. Eighty percent of the upper Yukon stocks had passed the Galena north site by September 2; 80% of Tanana stocks had passed the Galena south

Table 15. Tags observed on spawning grounds, 1976-1978.

System	1976			1977			1978			Total		
	No. tags	<u>1/</u> Esc.	Ratio	No. tags	<u>1/</u> Esc.	Ratio	No. tags	<u>1/</u> Esc.	Ratio	No. tags	<u>1/</u> Esc.	Ratio
Sheenjek	0	4.5	-	3	6	1:2.0	10	12.0	1:1.2	13	22.5	1:1.7
Fishing Branch	2	8.8	1:4.4	1	12	1:12.0	3	7.0	1:2.3	6	27.8	1:4.3
Toklat	27	0.9	1:0.3	83	12	1:0.1	85	12.0	1:1	195	33.0	1:0.2
Delta	1	0.6	1:0.6	19	17	1:0.9	1	12.0	1:12.0	21	35.0	1:1.6
TOTAL	30	28.3	1:0.9	106	47	1:0.4	99	43.0	1:43	235	118.3	1:0.5

1/ Escapement in thousands of salmon observed during ground surveys.

wheel by September 11. Little difference was seen in the timing of run peaks at the Tanana (Wheel 3) and Ruby (Wheel 4) sites in 1978 (Figure 16). In Table 16 timing of passage of the bulk of (approximately 70%) the fall runs by site of tagging by year is listed. Relative timing of runs, however, has been demonstrated to fluctuate rather widely between years; this makes an average date of passage for north bank and south bank runs of questionable value towards fisheries management. The 1978 tagging has demonstrated no distinctive run timing among stocks spawning within the upper Yukon or among stocks spawning within the Tanana River systems.

Realistic estimates of actual swimming rates have been developed based on 23 chum salmon tagged at Galena tagging wheel 2 and recovered by the Ruby tagging wheel (61 miles upstream) in 1977. The average rate of travel was 21.6 miles/day; nine individuals covered the distance between wheels at the rate of 30.5 miles/day. A 1978 analysis of rate of movement between project fishwheels (Tanana-Rampart 30 miles) indicated that approximately 20% traveled 9 miles or less a day, 52% 10-29 miles a day, 24% 30 or more miles per day (Table 17).

In 1978, 4.8% of the recoveries were downstream 10 miles or more below the wheel of tagging (Appendix Table 16).

Population estimation

Population estimation of Yukon fall chum for 1978 are presented in Table 18 and are discussed below. Population estimates of fall chum for the Yukon by year are also presented in Appendix Table 17 and are also discussed below. In these calculations the basic Petersen estimate was used (Ricker 1975). It is recognized that these estimations are subject to error. The estimations assumes certain criteria to be met including:

- 1) The marked fish suffer the same natural mortality as the unmarked,
- 2) The marked fish are as vulnerable to the fishing being carried on as are the unmarked ones,
- 3) The marked fish do not lose their mark,
- 4) The marked fish become randomly mixed with the unmarked or the distribution of fishing effort (in subsequent sampling) is proportional to the number of fish present in different parts of the body of water,
- 5) All marks are recognized and reported on recovery, and

Figure 16. Comparative run timing of fall chum as shown by cumulative daily catches, 1978.

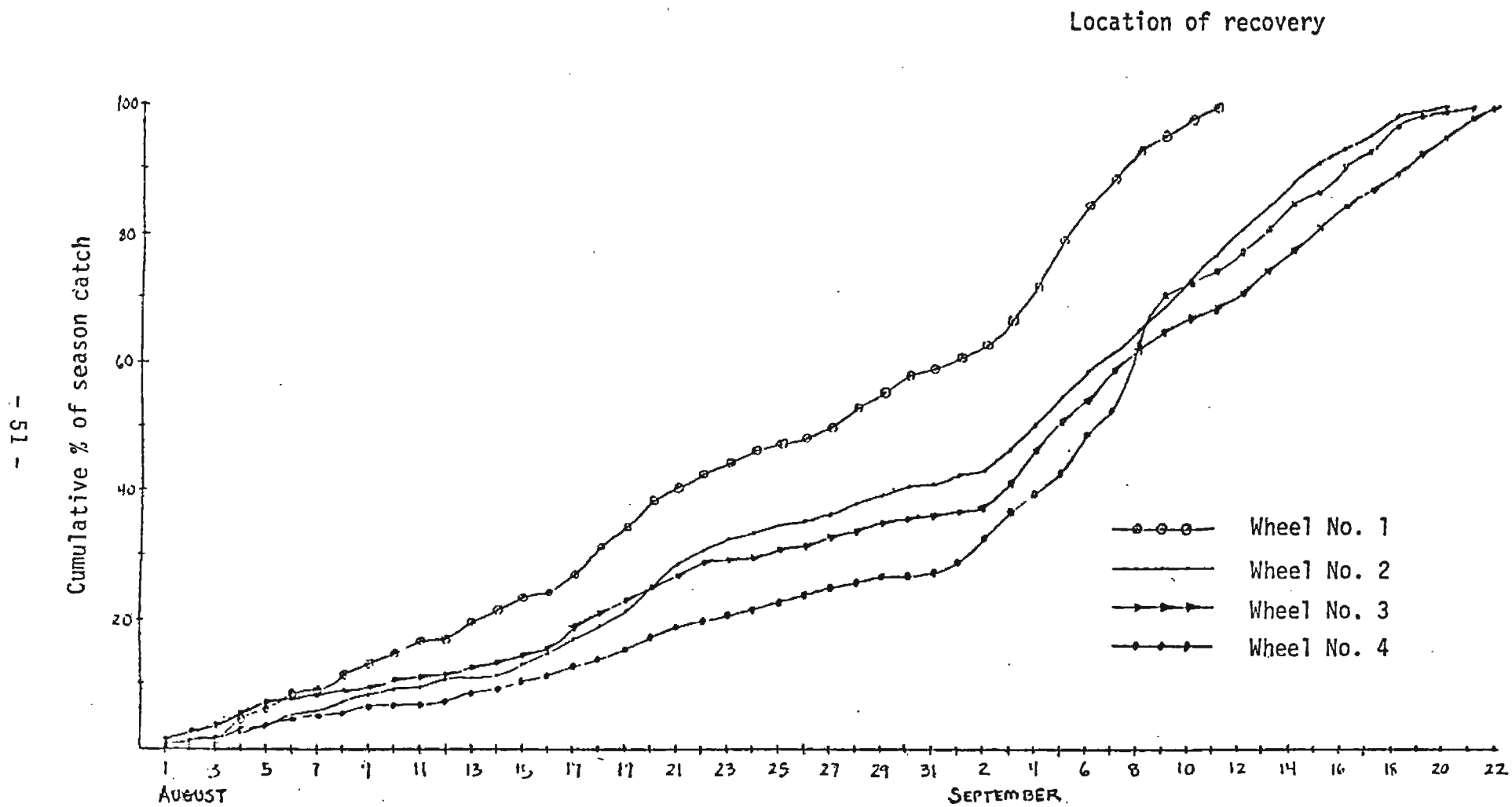


Table 16. Peak time periods and year of fall chum passage at tagging sites by drainage and year^{1/}.

Wheel No.	Year	Date	Range	No. days	Percent ^{2/}
1 Galena North	1976 & 1977	Aug 21 - Sept 5		15	71.3
2 Galena South	1976 & 1977	Aug 26 - Sept. 12		17	71.9
3 Ruby South ^{3/}	1977	Aug 25 - Sept 5		11	46.5
		Sept 13 - Sept 21		8	24.2
		Total		19	70.7
1 Yukon Rapids North	1978	Aug 20 - Sept. 8		19	70.2
2 Yukon Rapids ^{3/} South	1978	Aug 16 - Aug 23		8	18.6
		Sept 3 - Sept 16		14	52.2
		Total		22	70.8
3 Tanana Village	1978	Sept 3 - Sept 21		18	65.7
4 Ruby South	1978	Aug 17 - Sept 18		32	69.3

^{1/} Major spawning drainage: Yukon above Tanana and Tanana Rivers.
Only salmon recovered in above areas included in analysis.

^{2/} Percent tagged of total for year.

^{3/} For year and site two distinct and separate peaks were seen in recovery dates.

Table 18. Estimates of 1978 Yukon fall chum run in thousands of salmon.

<u>Upper Yukon including Tanana River</u> ^{1/}					
	<u>Harvest</u> ^{3/}	<u>Number</u> ^{4/} <u>Chums Tagged</u>	<u>Number</u> <u>Chums Recovered</u> ^{4/}	<u>Population</u> <u>Estimation</u>	
Subsistence	83				
Commercial	33				
Canada Subsistence and commercial	<u>10</u>				
Total	126	9,094	4,645	247	

Harvest and return upper Yukon various 1978						
	<u>Total</u> <u>Harvest</u>	<u>Observed</u> <u>Escapement</u>	<u>Calculated</u> <u>Population</u>	<u>Undocumented</u> <u>Escapement</u>	<u>Total</u> <u>Escapement</u>	<u>Rate of</u> <u>Exploitation</u>
Yukon upstream Ruby (includes Tanana)	126	88	243	29	117	0.52
Upper Yukon ^{4/}	75	30	105	10	40	0.71
Tanana River incl. Toklat	61	58	138	19	71	0.44
Toklat River ^{7/}	37	35	83	11	46	0.45

Entire Yukon

(1) Population estimation above Ruby	247
(2) Subsistence catch Ruby downstream	12
(3) Commercial catch Ruby downstream	201
Total Yukon population (1, 2, 3 above)	460
Total Yukon harvest	339
Rate of exploitation	0.74
Total observed escapement	88

^{1/} Population estimation upstream of Ruby. Simple Petersen estimation. Based on recoveries through Dec 31, 1978.

^{2/} Subsistence catch of fall chums from Yukon management data: 60% of upper Yukon subsistence catch is considered fall chum; 25% of lower Yukon subsistence catch considered fall chum.

^{3/} Commercial catch from AYK surveys of commercial fishermen in thousands of salmon.

^{4/} Does not include spawning ground recoveries of 99 fish, or downstream recoveries of 383 fish; also adjusted for 10% rate of tag loss or 92 fish which the author considers a minimal figure.

^{5/} Undocumented escapement calculated as difference between calculated population and sum of documented harvest and escapement.

^{6/} Calculated as difference between total Yukon run above Ruby and upper Yukon run above Tanana.

^{7/} Based on % Toklat run was of entire Tanana escapement for 1978.

- 6) There is only a negligible amount of recruitment to the catchable population during the time the recoveries are being made.

The effects of not meeting each of these criteria on population estimation are discussed by Ricker (1975). On the Yukon study it has been demonstrated that there is some shedding of tags. Population estimates were adjusted for a projected 10% tag loss due to shedding in the fishery and fishing mortality. Male fish have been demonstrated to be more susceptible to harvest gear, gillnets in particular, than females. From spawning ground observations it is known that all population segments have not been tagged to the same degree.

Despite the acknowledged sources of error, it is felt that the population estimates presented acceptably reflect actual abundance. Documented run strength including harvest and escapement of the Yukon River fall run for 1976, 1977, and 1978 were 314, 453, and 427 thousand, respectively. The calculated run for these respective years was 331, 513, and 460 thousand fish (Appendix Table 17). Differences between documented and calculated runs of 17, 60, and 33 thousand (5%, 13%, and 8%) are seen for these years, respectively. These differences could be easily ascribed to undocumented escapement. With 95% confidence limits the 1978 population range was 433-479 thousand fall chums. The rate of exploitation was 0.74 (Table 18 and Appendix Table 17).

For the upper Yukon above the Tanana confluence, the magnitude of the returning run (based on a Petersen estimate of tags recovered between project fishwheels) was 105 thousand fish for 1978. With 95% confidence limits, the estimated population would range from 100-110 thousand. The rate of exploitation was 0.71 (Table 18).

The rate of exploitation of Tanana system spawning stocks, total estimated population 138 thousand, was 0.44. The relatively low rate of exploitation found in spawning populations for the Tanana system as compared to the Yukon above Tanana may indicate that some stocks follow pathways other than up the river banks during their upriver migration. One such possibility would be along sandbars up the river's center. If this is the case, such populations are likely not exploited by existing upriver fisheries. Another reason for the rate of exploitation as indicated by tag returns is that these populations may be exposed to minimal harvest by upriver fisheries due to uniquely early or late run timing.

The 1978 run was the second weakest since good population data has become available (Appendix Table 17). The historically high documented population was 894 thousand in 1975 and the low, 331 thousand in 1976. The overall rate of exploitation has ranged from 0.40 in 1975 to 0.74 in 1978.

Summary

Four fishwheels were contracted in 1978 to tag fall chum salmon. These fishwheels were located from mile 601 to mile 725 along the Yukon River. Fishwheels were numbered upstream to downstream and were by number and river mile: (1) 725, (2) 724, (3) 695, and (4) 601. Tagging began at the Tanana (No. 3) and Ruby (No. 4) fishwheels on August 1 and concluded at the Tanana wheel on September 22.

During 1978, a total of 9,668 chum salmon and 124 coho salmon were tagged. Other species comprising a major portion of catches including king salmon, sheefish, broad whitefish, and humpback whitefish.

Catch success between years by fishwheel site was not directly comparable. Ruby fishwheel chum catches peaked earlier in 1977 than in 1978 with respective dates of high counts running August 26 and September 8, respectively.

Through January of 1979, 4,744 or 49% of the chum salmon tagged in 1978 had been recovered. Tag recovery rates varied from a low of 32% for chums tagged at the Ruby No. 4 site to a high of 57% for chums tagged at the upper Yukon No. 1 fishwheel.

Returns of 1977 chum tags through 1978 were 2,015 or 38%; returns of 1976 tags to date have been 613 or 50%. Differences in the expected and observed rate of tag returns by site of tagging may be explained in part by differences in the allocation of fishing effort. The major Tanana, Rampart, Hess Creek, and Stevens Village harvests are largely north bank and are taken from stocks which have been shown by tagging to be destined for upper-Yukon, Porcupine spawning areas.

Through January of 1979, 46 coho or 35.5% of those tagged have been recovered.

For the 3 years of the study, commercial recovery of tags has amounted to 52% and subsistence to 48%. The fishwheel has accounted for 60% of recoveries over this period while gillnet recoveries have run 31%. Spawning ground recoveries have run 3% of recoveries.

Overall, 97% of the 1,911 recoveries from the north bank sites below the Tanana River confluence, and identified as to major river system or recovery, were recovered in the upper Yukon. Out of 1,109 recoveries of south bank tagged chums recovered above the Tanana confluence, 1,009 or 91% were recovered within the Tanana system.

Of coho returns, 86% (46 total recoveries) have been from the Tanana or its tributaries.

Scale samples taken from major fall chum spawning grounds since 1974 have averaged 71% 4_1 . Toklat chums sampled have averaged 39%, 3_1 over this period.

Rates of movement between wheels of tagging have demonstrated that a high percentage of fall chum migrate at a rate of 20-30 miles per day.

The total estimated Yukon system population of fall chums for 1978 was 460,000 with an exploitation rate of 0.74. The 1978 run was the second weakest since good population data has become available. The high calculated population was 894,000 in 1975 and the low 331,000 in 1976. The overall rate of exploitation has ranged from 0.40 in 1975 to 0.74 in 1978.

The rate of exploitation of upper Yukon-Porcupine stocks by the upper Yukon fisheries was 0.71 for 1978. The rate of exploitation of Tanana total and Toklat stocks was much lower running 0.44 and 0.45, respectively.

The rate of exploitation found in spawning populations for the Tanana system may indicate that some stocks, such as the Delta River spawning follow pathways other than up the river banks during upriver migration. One such possibility would be along sandbars up the river's center. If this were the case, such populations are likely not exploited by existing upriver fisheries. Some populations may be exposed to minimal harvest by fisheries due to uniquely early or late run timing.

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APPENDIX

Appendix Table 1. Documented harvests and escapement of Yukon summer chum salmon (thousands of fish).

Year	Anvik Escapement	<u>1/</u> Yukon observed or calculated escapement	Comm. harvest	Subsis. harvest <u>2/</u>	Total harvest	Total run	Exploitation rate
78	224	549	1,053	58	1,111	1,655	.67
77	263	547	549	188	735	1,284	.57
76	406	856	598	166	764	1,620	.47
75	738	1,621	720	206	926	2,547	.36
74	263	356	606	218	824	1,180	.70
73	87	174 <u>1/</u>	253	140	393	567	.69
72	237	474 <u>1/</u>	80	105	185	659	.28
71	-	-	43	150	193	-	-
70	163	326 <u>1/</u>	106	167	273	599	.46
Total							
Ave. \bar{x} <u>3/</u>	2,381 298	4,903 613	4,008 444	1,398 155	5,404 600	10,116 1,264	.53 .68

1/ Anvik River av. 50% of Yukon total known escapement for base years 1974-78. Total escapement for years prior to 1974 calculated by expanding by 50%. Based on Appendix Table 2.

2/ Assumed to = 75% total river subsistence harvest of summer chum salmon data AYK files.

3/ Does not include 1971 for which escapement data lacking.

Appendix Table 2. Anvik River chum salmon expanded total escapements based on upstream tower counts and lower river aerial counts.^{1/}

Year	Total Upper River Tower ^{2/}	Lower River Aerial	Percent Lower River Aerial/Total Aerial ^{3/}	Total River
1978	150	74	37	
1977	163	100	38	263
1976	238	168	38	406
1975	602	136	16	738
1974	201	---	--	263 ^{4/}
1973	71	15	58	87
1972	100	138	56	237
1971	---	---	--	---
1970	---	---	--	163
Total	1,748	631	31	2,381
\bar{x}	249	105	--	298

1/ In thousands of salmon.

2/ Tower count unless indicated otherwise. No survey lower river 1974; lower or upper river 1971; survey 1970 was entire river.

3/ This percent is based on ratio of aerial surveys upstream to aerial surveys downstream. See Table 4.

4/ Total escapement calculated by expanding tower count by 31%.

Appendix Table 3. Cumulative daily counts of Anvik River chum past the tower site by year.

	1972	1973	1974	1975	1976	1977	1978
Date							
6-22		-	-	-	-	-	152
23		-	-	-	-	-	258
24		-	1,166	-	-	0	414
25		-	2,805	-	-	0	1,622
26		-	5,806	-	-	0	2,324
27		-	8,216	-	-	0	3,653
28		73	10,952	-	-	0	9,756
29		712	15,168	-	-	0	19,474
30		1,939	20,879	-	2	2	29,259
7-01		4,354	28,064	-	934	24	35,567
02		8,320	36,307	-	5,153	28	41,603
03		14,425	47,167	-	6,959	59	58,810
04		19,575	62,035	-	7,562	585	68,267
05	3,104	23,672	74,662	-	26,066	1,854	81,912
06	5,455	27,095	88,643	10,142	43,431	5,022	90,354
07	11,525	28,654	99,347	27,190	89,587	10,578	97,166
08	18,463	31,679	108,885	45,789	127,167	19,415	102,952
09	22,798	37,379	118,373	90,470	151,736	31,094	110,124
10	29,943	41,674	131,628	141,376	166,122	47,609	114,977
11	45,836	49,826	139,200	177,591	183,168	66,452	120,427
12	62,735	54,506	147,694	227,446	193,636	87,471	127,833
13	73,610	58,245	159,425	281,704	206,006	106,405	135,214
14	82,729	61,020	174,392	349,917	212,153	118,201	139,126
15	87,928	63,298	188,789	402,701	215,958	130,149	141,513
16	92,202	64,442	193,300	455,485	220,491	139,411	144,814
17	95,475	66,310	196,537	492,839	224,370	146,613	146,306
18	98,823	67,710	199,228	523,254	227,236	150,817	148,207
19	100,548	68,539	201,275	543,453	229,754	155,635	149,040
20	102,207	69,075	-	560,208	231,658	157,314	149,744
21	104,209	69,652	-	573,598	233,049	158,679	150,324
22	105,454	70,134	-	582,087	234,339	159,772	
23	106,179	70,451	-	589,527	235,693	160,973	
24	106,957	70,618	-	594,700	236,550	161,382	
25	107,361	70,734	-	597,943	236,963	161,848	
26	107,610	70,823	-	600,374	237,308	162,231	
27	107,888	70,885	-	601,870	237,587	162,514	
28	108,058	71,017	-	-	237,851	-	
29	108,160	71,250	-	-	-	-	
30	108,264	71,357	-	-	-	-	
31	108,342	71,475	-	-	-	-	
Total	108,342	71,475	201,275	601,870	237,851	162,514	150,324

Appendix Table 4. Chum salmon daily enumeration log including expanded tower, sonar, and total counts, Anvik tower, 1978.

Date	West Bank			Percent Total <u>3/</u> Cumulative	Midstream		Percent Total <u>3/</u> Cumulative	East Bank		Grand total incl. missing midstream & east bank days	Percent 1	Cum. Number	Percent Cumulative
	Sonar <u>1/2/</u>	Tower	Subtotal		Tower <u>1/3/</u>	Percent Total <u>3/</u> Cumulative		Tower <u>2/</u>	Percent Total <u>3/</u> Cumulative				
6/22		65	65		(11)			(26)		(102)	---	102	---
6/23		100	100		(16)			(40)		(156)	---	258	---
6/24		100	100		(16)			(40)		(156)	---	414	---
6/25	(642)	135	(777)		(126)			(305)		(1,208)	0.8	1,622	1.1
6/26	(436)	14	(460)		61			(181)		(702)	---	2,324	1.5
6/27	(1,133)		(1,133)		(184)			12		(1,329)	0.9	3,653	2.4
6/28	(4,135)		(4,135)		(670)			1,298		(6,103)	4.1	9,756	6.5
6/29	(7,291)		(7,291)		(1,181)			1,246		(9,718)	6.5	19,474	13.0
6/30	(7,456)		(7,456)		(1,208)			1,121		(9,785)	6.5	29,259	19.5
7/1	(4,356)		(4,356)		(706)			1,246		(6,308)	4.2	35,567	23.7
7/2	(4,444)		(4,444)		(720)			872		(6,036)	4.0	41,603	27.7
7/3	(9,017)		(9,017)		(1,461)			4,729		(15,207)	10.1	58,810	39.1
7/4	(3,605)		(3,605)		385			7,467		(11,457)	7.6	68,267	45.4
7/5	(8,601)		(8,601)		1,236			3,808		(13,645)	9.1	81,912	54.5
7/6	(4,322)		(4,322)		1,409			2,711		(8,442)	5.6	90,354	60.1
7/7	(3,610)		(3,610)		871			2,331		(6,812)	4.5	97,166	64.6
7/8	(3,149)		(3,149)		939			1,698		(5,786)	3.9	102,952	68.5
7/9	(4,404)		(4,404)		894			1,874		(7,172)	4.8	110,124	73.3
7/10	(3,258)		(3,258)		544			1,051		(4,853)	3.2	114,977	76.5
7/11	(4,157)		(4,157)		421			872		(5,450)	3.6	120,427	80.1
7/12	(5,868)		(5,868)		499			1,039		(7,406)	4.9	127,833	85.0
7/13	(5,986)		(5,986)		429			966		(7,381)	4.9	135,214	89.9
7/14		2,292	2,292		(371)			1,249		(3,912)	2.6	139,126	92.6
7/15		1,492	1,492		(242)			653		(2,387)	1.6	141,513	94.1
7/16		2,215	2,215		(359)			727		(3,301)	2.2	144,814	96.3
7/17		1,063	1,063		(172)			257		(1,492)	1.0	146,306	97.4
7/18		1,292	1,292		(209)			400		(1,901)	1.2	148,207	98.6
7/19		500	500		(96)			147		(833)	---	149,040	99.1
7/20		561	561		(91)			52		(704)	---	149,744	99.8
7/21		358	358		(58)			104		(580)	---	150,324	100
Total	(85,870)	10,275	(96,217)	64.0	(15,585)	9.3	(38,522)	25.6		(150,324)	100.0		

1/ Counts given in brackets have been calculated. Initial expansions for sonar: (a) partial hour expanded as straight ratio of fraction to whole; (b) partial day missing hours expanded based on data Appendix Table 6.

2/ Expansion for missing days: for midstream based on ratio of midstream counts to west bank counts for dates 6/26 and 7/4-7/13; for east bank based on ratio of east bank to west bank for dates 6/27-7/21. The midstream and east bank river sectors ran 16.2% and 39.5% respectively of the west bank.

3/ Percent of grand total 150,324.

Appendix Table 5. Daily summary of Anvik chum salmon sonar counts by sector and percentages, 1978 1/

		Sector												Number Hours		24 Hour
Date		1	2	3	4	5	6	7	8	9	10	11	12	Total	Used 2/	Expansion
6/25	Number	4	7	0	0	1	1	5	14	3	30	53	70	188	6	642
	Percent	2.1	3.7	0.0	0.0	0.5	0.5	2.7	7.4	1.6	16.0	28.2	37.2	100.0		
6/26	Number	6	1	6	8	1	1	7	4	1	4	21	45	105	5	436
	Percent	5.7	1.0	5.7	7.6	1.0	1.0	6.7	3.8	1.0	3.8	20.0	42.9	100.0		
6/27	Number	33	94	79	24	16	33	13	9	19	47	69	92	528	12	1,133
	Percent	6.3	17.8	15.0	4.5	3.0	6.3	2.5	1.7	3.6	8.9	13.1	17.4	100.0		
6/28	Number	231	323	300	164	169	204	61	60	89	228	317	335	2,401	13	4,135
	Percent	9.3	13.0	12.1	6.6	6.8	8.2	2.5	2.4	3.6	9.2	12.8	13.5	100.0		
6/29	Number	2,657	521	486	230	197	229	78	59	87	200	270	395	5,409	16	7,291
	Percent	49.1	9.6	9.0	4.3	3.6	4.2	1.4	1.1	1.6	3.7	5.0	7.3	100.0		
6/30	Number	1,067	1,536	1,083	282	280	298	132	105	241	219	236	344	5,823	19	7,456
	Percent	18.3	26.4	18.6	4.8	4.8	5.1	2.3	1.8	4.1	3.8	4.1	5.9	100.0		
7/1	Number	656	664	369	84	96	45	19	31	48	47	48	154	2,261	11	4,356
	Percent	29.0	29.4	16.3	3.7	4.2	2.0	0.8	1.4	2.1	2.1	2.1	6.8	100.0		
7/2	Number	904	1,304	491	161	277	204	60	67	114	163	214	361	4,320	23	4,444
	Percent	20.9	30.2	11.4	3.7	6.4	4.7	1.4	1.6	2.6	3.8	5.0	8.4	100.0		
7/3	Number	1,889	1,627	714	328	786	521	105	140	200	404	473	1,099	8,196	22	9,017
	Percent	23.0	19.9	8.7	4.0	9.6	6.4	1.3	1.7	2.4	4.9	5.8	12.3	100.0		
7/4	Number	174	312	203	105	139	40	22	25	54	113	130	89	1,406	9	3,605
	Percent	12.4	22.2	14.4	7.5	9.9	2.8	1.6	1.8	3.8	8.0	9.2	6.0	100.0		
7/5	Number	241	812	596	412	931	473	63	62	95	141	133	118	4,077	13	8,601
	Percent	5.9	19.9	14.6	10.1	22.8	11.6	1.5	1.5	2.3	3.5	3.3	2.9	100.0		
7/6	Number	138	240	199	202	198	233	134	66	94	145	162	108	1,919	9	4,322
	Percent	7.2	12.5	10.4	10.5	10.3	12.1	7.0	3.4	4.9	7.6	8.4	5.6	100.0		
7/7	Number	170	286	137	114	198	183	130	33	74	136	217	138	1,816	13	3,610
	Percent	9.4	15.7	7.5	6.3	10.9	10.1	7.2	1.8	4.1	7.5	11.9	7.6	100.0		
7/8	Number	415	604	339	138	145	141	132	73	142	247	276	166	2,818	21	3,149
	Percent	14.7	21.4	12.0	4.9	5.1	5.0	4.7	2.6	5.0	8.8	9.8	5.9	100.0		
7/9	Number	605	932	517	188	108	90	348	82	207	366	444	244	4,219	23	4,404
	Percent	16.2	22.1	12.3	4.5	2.8	2.3	8.2	1.9	4.9	8.7	10.5	5.8	100.0		
7/10	Number	526	686	312	103	66	55	134	49	105	281	408	178	2,903	21	3,258
	Percent	18.1	23.6	10.7	3.5	2.3	1.9	4.6	1.7	3.6	9.7	14.1	6.1	100.0		
7/11	Number	50	275	349	150	109	85	86	32	45	107	319	343	1,950	10	4,157
	Percent	2.6	14.1	17.9	7.7	5.6	4.4	4.4	1.6	2.3	5.5	16.4	17.6	100.0		
7/12	Number	144	798	1,205	367	244	146	95	85	38	145	364	425	4,056	16	5,068
	Percent	3.6	19.7	29.7	9.0	6.0	3.6	2.3	2.1	0.9	3.6	9.0	10.5	100.0		
7/13	Number	155	384	160	66	58	37	30	24	15	70	119	145	1,263	7	5,986
	Percent	12.3	30.4	12.7	5.2	4.6	2.9	2.4	1.9	1.2	5.5	9.4	11.5	100.0		
10,145		11,406	7,545	3,126	4,019	3,027	1,654	1,020	1,671	3,093	4,273	4,759	55,738	269	85,870	
18.2		20.5	13.5	5.6	7.2	5.4	3.0	1.8	3.0	5.5	7.7	8.5	100.0	59%		
														of possible		
														(459)		

1/ Only data that had not been interpolated was used in constructing this table. Percents were computed by; total for the day divided into the sector for that day. 2/ Number of hours (H) over which counts extended during day. 3/ Expansion for missing hours based on data developed on hourly migration rates and presented in Appendix Table 6. The expansion formula used was the same as the one used and discussed in the 1976 job completion report for Anvik counting lower data (Mauney, 1977).

Appendix Table 6. An analysis of Anvik River chum salmon net upstream counts by hour for 1973, 1976, and 1977. 1/ 2/

Hour	1973	%	1976	%	1977	%	Total	%
00	3,854	5.5	6,433	4.3	5,686	3.9	15,973	4.4
1	4,465	6.3	6,441	4.3	6,192	4.3	17,098	4.6
2	4,080	5.8	5,119	3.4	5,790	4.0	14,989	4.1
3	3,245	4.6	4,884	3.3	5,608	3.9	13,737	3.8
4	2,784	3.9	4,862	3.3	5,863	4.0	13,509	3.7
5	2,750	3.9	4,640	3.1	6,238	4.3	13,628	3.7
6	3,220	4.6	4,008	2.7	5,157	3.5	12,385	3.4
7	2,791	3.9	3,641	2.4	4,487	3.1	10,919	2.9
8	2,413	3.4	3,963	2.7	3,691	2.5	10,067	2.7
9	2,263	3.2	4,191	2.8	3,726	2.6	10,180	2.8
10	1,977	2.8	4,135	2.8	3,455	2.4	9,567	2.6
11	1,797	2.5	5,626	3.8	3,849	2.7	11,272	3.1
12	2,187	3.1	6,574	4.4	4,587	3.2	13,348	3.6
13	2,805	4.0	7,381	4.9	5,232	3.6	15,418	4.2
14	2,650	3.8	8,873	5.9	6,270	4.3	17,802	4.9
15	2,882	4.1	9,462	6.3	7,033	4.8	19,377	5.3
16	2,520	3.6	8,454	5.7	8,716	6.0	19,690	5.4
17	2,406	3.4	8,201	5.5	8,561	5.9	19,168	5.3
18	3,087	4.4	8,045	5.4	7,866	5.4	18,998	5.2
19	2,919	4.1	7,234	4.9	8,320	5.7	18,473	5.1
20	3,008	4.3	6,362	4.3	7,850	5.4	17,220	4.7
21	3,533	5.0	6,502	4.4	8,204	5.6	18,239	5.0
22	3,682	5.2	6,635	4.4	6,873	4.7	17,190	4.7
23	3,067	4.4	7,461	5.0	6,234	4.3	16,762	4.6
Total	70,394	100.0	149,127	100.0	145,488	100.0	365,009	100.0

1/ Based only on dates for which 24 hour counts available

2/ For counts by hour for 1973 and 1976. See 1976 Annual Tech. Report.

Appendix Table 7. Anvik River chum salmon escapement distributions as indicated by aerial survey 1975 through 1978.

Stream Location	Chum							
	1975		1976		1977 ^{2/} ^{6/}		1978	
	No.	%	No.	%	No.	%	No.	%
Below Goblet Creek	6,800	0.8	2,875	0.6	11,800	4.5	-	-
Goblet-Beaver	59,425	7.0	48,555	11.1	15,100	5.7	-	-
Goblet-B. B. Tree	-	-	-	-	-	-	7,072	3.5
Sonar site	-	-	-	-	-	-	2,975	1.5
Sonar Site -	-	-	-	-	-	-	20,975	10.4
Beaver Cr.	-	-	-	-	-	-	12,655	6.3
Beaver Creek	19,005	2.3	25,700	5.7	30,500	11.6	21,880	10.8
Beaver-Yellow River	50,900	6.0	24,475	5.6	26,700	10.1	-	-
Yellow River	<u>3/</u>	-	38,680	8.8	3,000	1.1	-	-
Yellow River-	-	-	-	-	-	-	-	-
Robinhood Creek	<u>4/</u>	-	25,200	5.8	12,800	4.9	8,900	4.4
Robinhood Creek	<u>3/</u>	-	<u>2,830</u>	<u>0.6</u>	<u>400</u>	<u>0.2</u>	-	-
Subtotal Lower	136,130	16.1	168,315	38.0	100,300	38.2	74,457	36.6
River	-	-	-	-	-	-	-	-
Robinhood Creek-	<u>4/</u>	-	24,150	5.6	-	-	25,200	12.5
Old Tower Site	-	-	-	-	-	-	-	-
Yellow River-	75,000	8.9	<u>4/</u>	-	-	-	-	-
75 Tower	-	-	-	-	-	-	-	-
75 Tower-	<u>4/</u>	-	18,700	4.3	-	-	-	-
Runkles Creek	-	-	-	-	-	-	34,900	17.3
75 tower - Swift R.	-	-	-	-	-	-	-	-
Runkles Creek-	<u>4/</u>	-	29,000	6.6	-	-	-	-
Swift River	-	-	-	-	-	-	-	-
Swift River	21,545	2.6	38,335	8.7	-	-	13,100	6.5
Swift River-	<u>4/</u>	-	56,375	12.9	-	-	27,110	13.4
Otter Creek	-	-	-	-	-	-	-	-
75 Tower-	345,200	40.9	<u>4/</u>	-	-	-	-	-
Otter Creek	-	-	-	-	-	-	-	-
Otter Creek	47,645	5.6	47,585	10.9	-	-	9,440	4.7
Canyon Creek	<u>3/</u>	-	3,855	0.9	-	-	1,105	0.5
Otter Creek-	215,250	25.5	47,375	10.9	-	-	14,320	7.1
McDonald Creek	-	-	-	-	-	-	-	-
McDonald Creek	2,470	0.3	4,465	1.0	-	-	1,625	0.8
Above McDonald	<u>250</u>	-	<u>5/</u>	-	-	-	530	-
Subtotal Upper	707,360	83.9	269,840	62.0	162,500	61.8	127,430	62.9
River	843,490	100.0	438,155	100.0	262.8	100.0	201,887	100
Total River	-	-	-	-	-	-	-	-

1/ Aerial survey dates: 1978 7-14, 1977 7-16, 7-20, 7-21, 7-21; 1975 7-23.

2/ Counts not representative of actual numbers of king salmon in system.

3/ Not surveyed.

4/ Survey not broken down in this manner.

5/ Fewer than 200 chum.

6/ No aerial survey above 77 weir. Upper river escapement figure weir count only.

Appendix Table 8. King salmon daily enumeration log including expanded tower sonar, and total counts Anvik tower, 1978.^{1/}

Date	West Bank Sonar	East Bank Tower and Midstream	Total River ^{2/}		Cumulative	
			Number	Percent	Number	Percent
6/22-7/1	0	0	0	---	0	0
7/2	0	1	1	---	1	0
7/3	0	1	1	---	2	0
7/4	(1) ^{3/}	2	(3)	---	5	1
7/5	43	8	51	5	56	5
7/6	0	9	9	8	65	6
7/7	-4	26	22	2	87	8
7/8	25	43	68	6	155	14
7/9	19	47	66	6	221	20
7/10	3	21	24	2	245	23
7/11	49	38	87	8	332	31
7/12	2	43	45	4	377	35
7/13	37	92	129	12	506	47
7/14	(43) ^{3/}	81	(124)	11	630	58
7/15	---	---	115	11	745	68
7/16	---	---	102	9	847	78
7/17	---	---	73	7	920	85
7/18	---	---	88	8	1,008	93
7/19	---	---	27	2	1,035	95
7/20	---	---	23	2	1,058	97
7/21	---	---	30	2	1,088	100
Total	218	412	1,088	100	1,088	100

^{1/} Initial expansions: (1) partial hour expanded as straight ratio of function to whole and (2) partial day missing hours expanded from actual counts using factors developed from base years (Mauney, 1977).

^{2/} After 7-15 tower counts were for entire river.

^{3/} Missing days sonar calculated for percent sonar was of entire 7/5-7/13 period or 34.7.% of total river.

Appendix Table 9. Cumulative daily counts of Anvik River king salmon past the tower site by year.

Date	1972	1973	1974 ^{1/}	1975	1976	1977	1978
6-22	-	-	-	-	-	-	0
6-23	-	-	-	-	-	-	0
6-24	-	-	3	-	-	0	0
6-25	-	-	3	-	-	0	0
6-26	-	-	3	-	-	1	0
6-27	-	-	3	-	0	1	0
6-28	-	-	3	-	0	1	0
6-29	-	1	3	-	0	1	0
6-30	-	1	3	-	0	1	0
7-1	-	1	4	-	0	1	0
7-2	-	3	7	-	0	1	1
7-3	-	6	20	-	0	1	2
7-4	-	10	33	-	0	1	5
7-5	-	12	53	-	3	1	56
7-6	9	18	75	2	10	5	65
7-7	10	17	113	3	22	10	87
7-8	12	23	133	17	51	26	155
7-9	15	39	160	45	81	44	221
7-10	30	56	230	58	115	69	245
7-11	75	81	262	66	159	135	332
7-12	130	106	276	75	217	215	377
7-13	199	129	289	90	302	313	506
7-14	274	152	317	107	343	450	630
7-15	341	170	386	121	403	557	745
7-16	438	180	415	135	480	682	847
7-17	423	222	434	146	587	795	920
7-18	513	271	472	184	655	930	1,008
7-19	545	302	-	200	694	992	1,035
7-20	587	335	-	218	723	1,051	1,058
7-21	641	362	-	254	738	1,099	1,088
7-22	665	393	-	264	805	1,140	-
7-23	735	427	-	310	851	1,161	-
7-24	808	435	-	321	893	1,195	-
7-25	867	443	-	367	920	1,239	-
7-26	961	452	-	395	938	1,260	-
7-27	1,010	458	-	465	956	-	-
7-28	1,044	484	-	505	958	-	-
7-29	1,062	498	-	548	-	-	-
7-30	1,087	513	-	-	-	-	-
7-31	1,104	517	-	-	-	-	-
Total	1,104	517	472	548	958	1,260	1,088

^{1/} Counts terminated early due to high water.

Appendix Table 10. Pink salmon daily enumeration log including expanded tower, sonar, and total counts Anvik Tower, 1978.

Date	East Bank	West Bank	Daily Total	Cum. Total	Cum. %
6/22-7/3	0	0	0	0	0
7-4	-	25	25	25	10
5	1	48	49	74	30
6	5	12	17	91	37
7	4	0	4	95	38
8	4	7	11	106	43
9	1	2	3	109	44
10	8	8	16	125	50
11	15	15	30	155	62
12	1	5	6	161	65
13	4	24	28	189	76
14	29	-	29	218	88
15	7	-	7	225	90
16	7	-	7	232	93
17	3	-	3	235	94
18	8	-	8	243	98
19	2	-	2	245	98
20	0	-	0	245	98
21	4	-	4	249	100
Total	103	146	249		

Appendix Table 11. Numbers of chum salmon tagged by wheel and date, 1978.

DATE	WHEEL No. 1		WHEEL No. 2		WHEEL No. 3		WHEEL No. 4	
	No.	Cumulative %	No.	Cumulative %	No.	Cumulative %	No.	Cumulative %
Aug 1	--	--	--	--	38	1.3	9	0.3
2	--	--	--	--	36	2.5	24	1.2
3	29	1.4	--	--	41	3.9	16	1.8
4	60	4.4	43	2.2	43	5.4	26	2.7
5	33	6.0	33	3.9	43	6.8	28	3.8
6	49	8.4	27	5.3	28	7.8	23	4.6
7	7	8.7	15	6.0	13	8.2	16	5.2
8	58	11.6	24	7.3	18	8.8	16	5.8
9	33	13.2	17	8.1	24	9.6	14	6.3
10	28	14.6	21	9.2	21	10.4	9	6.6
11	41	16.6	7	9.6	13	10.8	9	6.6
12	25	17.8	14	10.3	19	11.4	18	7.6
13	41	19.8	12	10.9	23	12.2	20	8.4
14	30	21.3	13	11.6	42	13.7	31	9.5
15	52	23.8	30	13.1	42	15.1	23	10.3
16	44	26.0	33	14.8	55	16.9	17	11.0
17	55	28.7	43	17.0	44	18.4	36	12.3
18	50	31.1	44	19.2	62	20.5	43	13.9
19	60	34.1	48	21.7	65	22.8	45	15.5
20	82	38.1	66	25.1	62	24.9	44	17.1
21	42	40.2	61	28.2	59	26.9	41	18.6
22	41	42.2	48	30.6	42	28.3	21	19.4
23	40	44.1	36	32.5	25	29.1	20	20.1
24	40	46.1	22	33.6	19	29.8	23	21.0
25	26	47.4	20	34.6	26	30.7	32	22.1
26	19	48.3	11	35.2	29	31.6	38	23.5
27	35	50.0	19	36.1	31	32.7	32	24.7
28	58	52.9	36	38.0	35	33.9	19	25.4
29	56	55.6	31	39.6	26	34.8	20	26.1
30	48	58.0	17	40.4	16	35.3	13	26.6
31	20	59.0	13	41.1	16	35.9	18	27.3
Sep 1	36	60.7	19	42.1	12	36.3	46	29.0
2	44	62.9	22	43.2	21	37.0	98	32.6
3	75	66.6	56	46.1	123	41.2	109	36.5
4	111	72.0	79	50.1	148	46.2	76	39.3
5	146	79.2	92	54.8	120	50.3	93	42.7
6	103	84.2	73	58.5	111	54.0	165	48.8
7	89	88.6	65	61.9	120	58.1	100	52.5
8	92	93.1	64	65.1	116	62.0	286	62.9
9	56	95.8	70	68.7	71	64.4	213	70.7
10	44	98.0	81	72.9	61	66.5	55	72.8
11	41	100.0	78	76.8	60	68.6	36	74.1
12	--	---	73	80.6	59	70.6	102	77.8
13	--	---	80	84.7	118	74.6	96	81.3
14	--	---	69	88.2	97	77.9	101	85.0

Appendix Table 11. Numbers of Chum salmon tagged by wheel and date, 1978.(continued)

DATE	WHEEL No. 1		WHEEL No. 2		WHEEL No. 3		WHEEL No. 4	
	No.	Cumulative %	No.	Cumulative %	No.	Cumulative %	No.	Cumulative %
Sep 15	--	---	64	91.5	100	81.3	44	86.7
16	--	---	48	93.9	99	84.6	109	90.7
17	--	---	39	95.9	75	87.2	57	92.7
18	--	---	44	98.2	72	89.6	132	97.6
19	--	---	27	99.5	81	96.4	20	98.3
20	--	---	9	100.0	96	95.6	26	99.3
21	--	---	--	---	87	98.6	20	100.0
22	--	---	--	---	42	100.0	--	---
TOTAL	2309	100.0	1956	100.0	2945	100.0	2728	100.0

Appendix Table 12: Comparative data showing numbers of coho salmon tagged by date for 1977 and 1978.

DATE		1977 ^{1/}		1978 ^{2/}	
		No.	Cumulative %	No.	Cumulative %
Aug	22	1	1	0	0
	23	1	1	2	2
	24	1	1	0	2
	25	1	2	0	2
	26	5	4	1	2
	27	6	7	0	2
	28	11	11	0	2
	29	7	14	1	3
	30	4	16	0	3
	31	4	18	0	3
Sep	1	4	20	0	3
	2	14	26	1	4
	3	21	35	3	6
	4	14	41	4	10
	5	22	51	4	13
	6	4	53	4	16
	7	10	57	5	20
	8	15	64	12	30
	9	14	70	6	34
	10	3	71	5	39
	11	0	71	13	49
	12	2	72	1	50
	13	7	75	5	54
	14	2	75	3	56
	15	5	78	2	58
	16	8	82	11	67
	17	7	85	2	68
	18	3	86	13	79
	19	3	87	10	87
	20	12	93	5	91
	21	5	95	7	97
	22	2	96	4	100
	23	0	96	---	---
	24	3	97	---	---
	25	0	97	---	---
	26	2	98	---	---
	27	3	99	---	---
	28	1	99	---	---
	29	0	99	---	---
	30	1	100	---	---
TOTAL		228	100	124	100

^{1/}Numbers of coho tagged by fishwheel, 1977

Site	No.	Total %
1	12	5
2	9	4
3	207	91
TOTAL	228	100

^{2/}Total numbers of coho tagged by fishwheel 1978

Site	No.	Total %
1	0	0
2	4	3
3	23	19
4	97	78
TOTAL	124	100

Appendix Table 13. Numbers of chum salmon captured and the cumulative catch percentages for the Ruby fishwheel for 1977 and 1978. 1/

DATE		1977			1978		
		No.	Percentage		No.	Percentage	
			Daily	Cumulative		Daily	Cumulative
Aug	1	---	--	---	9	0	0
	2	---	--	---	24	1	1
	3	---	--	---	16	0	2
	4	---	--	---	26	1	2
	5	---	--	---	30	1	3
	6	---	--	---	24	1	4
	7	---	--	---	16	0	4
	8	---	--	---	16	0	5
	9	---	--	---	14	0	5
	10	14	1	1	9	0	6
	11	25	1	2	9	0	6
	12	36	1	3	18	1	7
	13	28	1	4	20	1	7
	14	24	1	5	34	1	8
	15	27	1	6	25	1	9
	16	16	1	7	19	1	10
	17	12	0	7	37	1	11
	18	3	0	7	47	1	12
	19	4	0	7	48	1	14
	20	10	0	8	46	1	15
	21	8	0	8	41	1	16
	22	7	0	8	22	1	17
	23	31	1	10	20	1	18
	24	71	3	12	24	1	18
	25	121	5	17	33	1	19
	26	156	6	23	28	1	20
	27	219	9	32	33	1	21
	28	159	6	38	19	1	22
	29	41	2	39	20	1	22
	30	57	2	42	13	0	23
	31	27	1	43	18	1	23
Sep	1	54	2	45	47	1	25
	2	75	3	48	104	3	28
	3	83	3	51	110	3	31
	4	81	3	54	79	2	34
	5	75	3	57	97	3	37
	6	42	2	59	170	5	42
	7	30	1	60	103	3	45
	8	43	2	62	292	9	54
	9	41	2	63	215	7	61
	10	32	1	64	217	7	68
	11	21	1	65	205	6	74
	12	15	1	66	178	5	79
	13	37	1	67	134	4	83
	14	65	3	70	112	3	87
	15	65	3	72	46	1	88
	16	52	2	74	113	3	92
	17	72	3	77	60	2	94
	18	61	2	79	138	4	98
	19	41	2	81	21	1	99

Appendix Table 13. Numbers of chum salmon captured and the cumulative catch percentages for the Ruby fishwheel for 1977 and 1978 (continued).

DATE		1977			1978		
		No.	Percentage		No.	Percentage	
			Daily	Cumulative		Daily	Cumulative
Sep	20	96	4	85	26	1	99
	21	72	3	88	20	1	100
	22	72	3	90	---	-	---
	23	56	2	93	---	-	---
	24	52	2	95	---	-	---
	25	53	2	97	---	-	---
	26	43	2	98	---	-	---
	27	16	1	99	---	-	---
	28	7	0	99	---	-	---
	29	10	0	100	---	-	---
	30	9	0	100	---	-	---
	TOTAL		2,567		100	3,245	

1/ Fishwheel operations in 1977 were begun on August 10. Fishwheel operations in 1978 were terminated September 21. The Fishwheel used in 1978 was a three basket model; the wheel used in 1977 had two baskets,

Appendix Table 14. Non-salmon species by fishwheel of capture, 1978 .

Species	Yukon #1	Yukon #2	Yukon #3	Yukon #4	Total
Broad whitefish (<u>Coregonus nasus</u>)	81	144	342	547	1,114
Burbot (<u>Lota lota</u>)		4	6	12	22
Char (<u>Salvelinus alpinus</u>)			1		1
Round whitefish (<u>Prosopium cylindraceum</u>) and Least Cisco (<u>Coregonus sardinella</u>)	347	860	503	71	1,781
Humpback whitefish (<u>Coregonus pidschian</u>)	165	213	393	110	881
Pike (<u>Esox lucius</u>)				6	6
Sheefish (<u>Stenodus leucichthys</u>)	156	95	311	8	570
Sucker (<u>Catostomus catostomus</u>)	3	17	60	130	210
Unknown whitefish	24	30			54

Appendix Table 15. Age composition of fall chum stocks by spawning grounds, 1973-1978.

Age	Year	Fishing Branch		Sheenjek		Toklat		Delta		Total	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
3 ₁	1973	---	---	---	---	---	---	33	11		
	1974	---	---	91	66	139	73	220	50		
	1975	---	---	7	5	---	---	8	3		
	1976	---	---	2	2	73	43	5	1		
	1977	25	31	20	11	52	27	47	11		
	1978	7	4	15	8	32	16	---	---		
Total		32	13	135	16	296	39	313	17	776	21
4 ₁	1973	---	---	---	---	---	---	240	76		
	1974	---	---	41	30	51	26	206	47		
	1975	---	---	187	95	---	---	253	93		
	1976	---	---	52	44	91	53	325	93		
	1977	52	65	129	73	135	69	390	88		
	1978	128	73	156	82	152	75	---	---		
Total		180	71	565	69	429	56	1,414	78	2,588	71
5 ₁	1973	---	---	---	---	---	---	39	13		
	1974	---	---	4	3	1	1	12	3		
	1975	---	---	3	2	---	---	10	4		
	1976	---	---	64	54	8	5	20	6		
	1977	3	4	29	17	10	5	5	1		
	1978	40	23	19	10	19	9	---	---		
Total		43	17	119	15	38	5	86	5	286	8
Grand Total		255	100	819	100	763	100	1,813	100	3,650	100

Appendix Table 16. Downstream movement of tagged fall chum by fishwheel of tagging 1978 (distance in miles).

Distance Recovered below Tagging Wheel	<u>Wheel Number</u> ^{1/}									
	1	% ^{2/}	2	%	3	%	4	%	Total	%
30 or over	91	7.9	15	1.3	16	1.0	6	0.7	128	2.7
20-29	7	0.6	44	4.0	16	1.0	4	0.5	71	1.5
10-19	16	1.4	6	0.5	1	-	4	0.5	27	0.6
9 or less	82	7.0	65	5.8	10	0.6	0	0	157	3.4
Total	196	11.0	130	11.7	43	2.8	14	1.6	383	8.2

^{1/} Wheel #1 - Upper Yukon north bank
 2 - Upper Yukon south bank
 3 - Tanana Village north bank
 4 - Ruby south bank

^{2/} Based on % of total tag recoveries by wheel of tagging: 1 = 1,156; 2 = 1,107,
 3 = 1,562; 4 = 857; Total = 4,682.

Appendix Table 17. Yukon River population estimations of fall chum salmon
in thousands of salmon 1974-1978.

	Total Harvest <u>1/</u>	Observed Escapement <u>2/</u>	Calculated Population	Undocumented Escapement <u>4/</u>	Total Escapement	Rate of Exploitation
Yukon Entire by year <u>3/</u>						
1974	369	144	513	-		0.72
1975	355	539	894	-		0.40
1976	236	78	331	17	95	0.71
1977	339	114	513 <u>4/</u>	60	174	0.66
1978	339	88	460 <u>4/</u>	29	117	0.74
Total	1,638	963	2,690	89		
\bar{x}	328	193	538	45		

1/ Total harvest includes both commercial and subsistence catches. From data AYK files.

2/ Escapement data usually based on peak aerial surveys from data AYK Files.
For years 1974 and 1975 escapement total included Fishing Branch weir count.

3/ Calculated population is computed by summing upper Yukon population estimation
from tagging where available and lower River harvest.

4/ Population estimation based on Peterson population estimation from fall tagging.